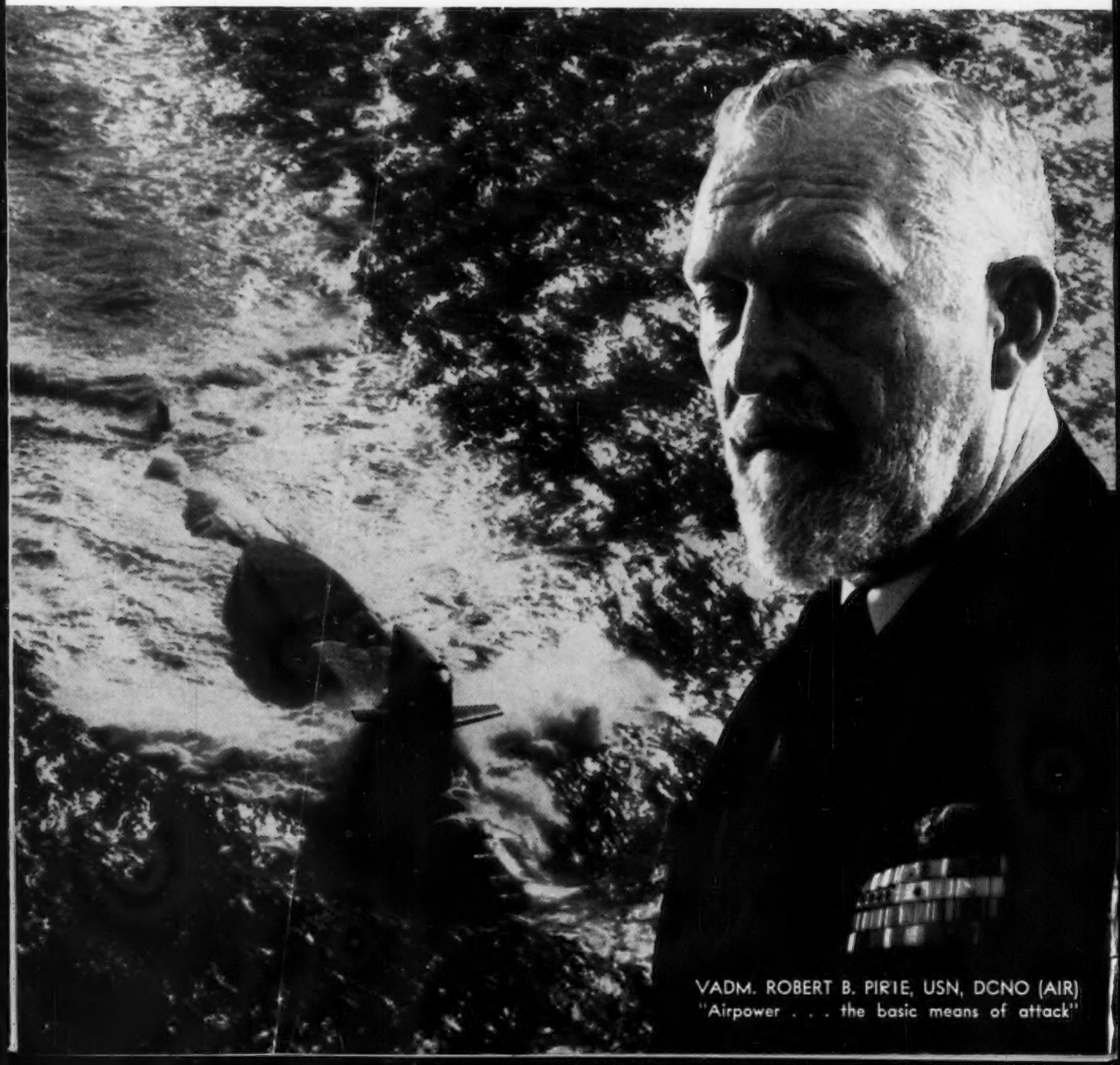
AIRCRAFT & MISSILES

A Chilton Publication APPLIED ENGINEERING FOR THE AEROSPACE INDUSTRIES April 1961

INTELLIGENCE REPORT–AIRPOWER IN SOVIET NAVY . . . P 27

The Fight For Purchased Parts Quality . . . P 22

ASW SPECIAL–THE CHALLENGE AND THE PROGRESS . . . P 33



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- National Bureau of Standards in Relation to United States Standards

TRACEABILITY AND GOVERNMENT REQUIREMENTS
- Traceability of Standards
- Enforceable Standardization for Space Age Requirements
- MIL Specifications and Government Directives

DERIVATION OF STANDARDS
- Prototype Standards
- Derived Standards
- Classification of Standards:
  - Legal
  - Reference
  - Laboratory
  - Working

HUMAN FACTORS IN STANDARDS
- Interest
- Aptitude
- Integrity

INSTRUMENTATION
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  - Fixed Instruments
  - Mechanical Instruments
  - Electronic Instruments
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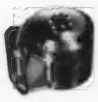

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April, 1961

Volume 4, Number 4

AIRCRAFT & MISSILES

APPLIED ENGINEERING FOR THE AEROSPACE INDUSTRIES

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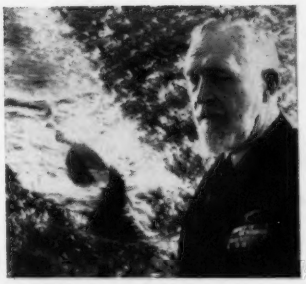
THE COVER STORY—The technologies of the outer space and "inner space" are amazingly complementary. "Inner space" is the term Navy chose some months ago to describe the deep ocean environment. Beginning on page 33 is a Special Staff Report that brings the challenge and the progress in ASW into sharp focus. Pictured is VADM. R. B. Pirie, DCNO(Air), the man who sets the requirements for Navy's ASW aircraft.



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NUCLEAR POWER—Experts agree that full-scale exploration and utilization of space hinges on nuclear power. Upper stages of space vehicles will use nuclear power for propulsion. Megawatt electrical power from auxiliary systems will come from nuclear reactors. This issue contains a summing up and a forecast of aerospace nucleonics.

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Your Datebook

April 4-6
Conference on Lifting Re-entry Vehicles: Structures, Materials, Design Structures and Materials Committee, the American Rocket Society
Riviera Hotel, Palm Springs, Calif.

April 4-7
National Aeronautic Meeting
Society of Automotive Engineers
Hotel Commodore, N. Y., N. Y.

April 5-7
Annual Meeting
Institute of Environmental Sciences
Sheraton Park Hotel, Washington, D. C.

April 10-14
International Symposium on Aviation Research and Development
Federal Aviation Agency
Atlantic City, N. J.

April 10-11
Spring Meeting, Western States Section, The Combustion Institute
Aeronutronic Div., Ford Motor Co.
Newport Beach, Calif.

April 13-14
Annual Meeting
National Aeronautical Services Assn.
Hotel Washington, Washington, D. C.

April 17-21
42nd Annual Meeting and Welding Show
American Welding Society
Commodore Hotel and Coliseum, N. Y., N. Y.

April 17-28
14th Technical Conference
International Air Transport Assn.
Queen Elizabeth Hotel, Montreal, Canada

April 18-20
Symposium on Chemical Reactions in the Lower and Upper Atmosphere
Stanford Research Institute
Mark Hopkins Hotel, San Francisco, Calif.

April 19-21
Southwestern Conference & Electronics Show
Institute of Radio Engineers
Memorial Auditorium and the Baker Hotel, Dallas, Tex.

April 20-22
General Meeting
American Meteorological Society, American Geophysical Union
Washington, D. C.

April 23-25
Metals Engineering Conference
The American Society of Mechanical Engineers
Penn Sheraton Hotel, Pittsburgh, Pa.

April 24-26
Powder Metallurgy Show and Technical Meeting
Metal Powder Industries Federation
Hotel Sheraton-Cleveland, Cleveland, O.

April 24-27
32nd Meeting
Aerospace Medical Assn.
Palmer House, Chicago, Ill.

April 26-28
Liquid Rockets, Propellants and Combustion Conference
American Rocket Society
Palm Beach Biltmore, Palm Beach, Fla.

April 26-28
Seventh Region Technical Conference
Institute of Radio Engineers
Hotel Westward Ho, Phoenix, Ariz.

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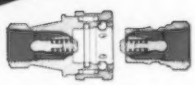

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Are Free Seas Worth Another $ Billion?

A strong, willing fighter, the U. S. Navy has seldom been known as modest. Of course, we'll admit that the Marines stole a lot of the brass—but not all.

Navy tells us that the U. S. anti-submarine warfare program is at least 5 to 10 years ahead of the Russians'. Yet, no one in Navy will admit it publicly by attaching his name to the statement. It's evidently classified.

Sure the program can be better. As long as we're ahead, let's stay far ahead for a change. Give Navy another $1 billion for the shopping list already in Deputy Secretary of Defense Gilpatrick's hands. Nothing on the list is a dramatic breakthrough—it is primarily more of what's on order now.

Without question, the Soviet submarine force (an estimated 400 plus) is the most potent naval threat facing us. We must have a neutralizing force. To do this, Navy needs three basic things—long-range underwater detection, discrimination, and long-range weapons.

Certainly, Navy's ultimate aim is to wage a successful underwater campaign—seek and destroy all offensive weapons. But today, this is not possible. Anti-submarine warfare means much, much more at the utmost. Our underwater defense is not perfect. For a true anti-submarine offense, other related tasks must be considered.

Bases or ports and tenders administering to enemy craft must be neutralized. How? Mainly airpower, either manned or unmanned. In this job, Air Force too should play an important role. If the two primary missions—sub and base destruction—cannot be carried out successfully, subs must be prevented from returning to port. This then involves another joint effort—naval underseas, surface, and air forces.

To the aerospace industries, ASW is—without question—a vital technical task. A challenge in airpower—fixed or rotary-wing; missilry—pure underwater, air-to-underwater, surface-to-underwater, surface craft-to-land or surface craft, and even underwater-to-air-to-underwater. Its a challenge in areas once thought far afield—items such as underwater propulsion, surface craft design (hydrofoil), and underwater communications, guidance, and electronics in general.

To the government leaders, whether executive or legislative, ASW should be a vital issue. You have the opportunity to stay ahead—no faltering or fooling around as you have been accused in the missile program. Will you accept the challenge to stay ahead or be complacent? Gentlemen, the public wants action not another gap.

Tom MacNew
Editor

LepeL

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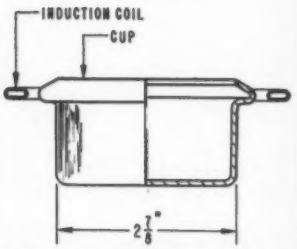

Flanges of cups made from type 321 stainless steel are selectively annealed by induction heating prior to further forming. Flanges are heated to 2000° F and water quenched. Single-turn coil restricts heating to the flange area.

Our engineers will process your work samples and return the completed job with full data and recommendations without cost or obligation.

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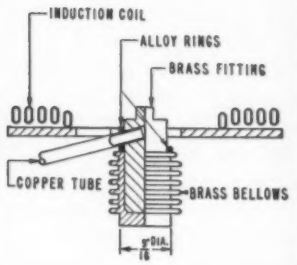

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Reader's Orbit

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. . . I feel honored that you chose to use my photograph on your cover . . . have just finished reading the featured story on your Saturn . . . I should like to express our appreciation for this nice story and congratulate you and Mr. Kushnerick on a job well done. Please extend my thanks to him.

Wernher von Braun, Director
Marshall Space Flight Center

"Well Done" From CNO

. . . (re February A&M) . . . the very excellent article on Polaris motor cases points out dramatically the continuing advantage the Navy takes of advances in state of the art.

It is the type of reporting that is needed to tell the Polaris story. I express my great appreciation for a job well done.

Adm. Arleigh Burke, USN
Chief of Naval Operations

Plastic Polaris

. . . (re February A&M) . . . we appreciate the reference to Hercules Powder Company and the part we have played in the design and development of resin-impregnated glass-filament wound cases for the advanced version of the Polaris missile.

J. M. Martin, Vice President
Hercules Powder Co.

re. the article entitled "Plastics Polaris Planned" on page 15 of your February, 1961 issue. This is certainly one of the finest and most complete articles on existing filament winding techniques which I have seen.

R. A. Manildi
Sales Manager
Coast Mfg. & Supply

Reprints Exhausted

It is my understanding that you recently had an excellent article titled "Plastic Polaris Plan" which covered the work being done in the manufacture of filament wound booster cases.

I would be interested in receiving several copies of this article if available, or at least information as to where this article can be obtained.

P. G. Verhoeven, Manager
Los Angeles Field Office
Goodyear Aircraft Corp.

Copy has been mailed, our stock of reprints on this article has been depleted.

Materials Selector

We were quite interested in the article "Materials Selector For Propellant Systems." Particularly were we encouraged with the comparison of tensile strength between "Teflon" 100 FEP-fluorocarbon resin and 'Kel-F' 300 when immersed in N_2O_4 . . . would appreciate five reprints.

J. P. Shoffner
Section—"Teflon"
E. I. Dupont & Co.

Bullpup Mix-up

. . . received with interest your March, 1961, Annual Handbook Issue. In reading your specs on our BULLPUP air-to-surface missile, we find a few errors. Following is a revision of your items on BULLPUP and BULLPUP B which are intended for your information and edification: We have an interesting problem in this missle since there are two services using basically four versions of a missile carrying one name—BULLPUP. . . . The Navy and the Air Force have the same missile in the A version, but they have gone different ways in the B. We would like to give you more information on both B versions, but both are still involved in classification. In fact, GAM-83B's external configuration has not been cleared for release yet.

Julian Levine
Information Services
The Martin Co.

Annual Forecast Issue

Secretary of Defense McNamara has asked me to thank you for . . . the copy of the Annual Forecast Issue of "Aircraft and Missiles." The research forecast as provided in the survey of the AIA technical committee's report is an interesting summation and several of our people in the Office of the Director of Defense Research and Engineering are aware of it.

The account of the Von Braun team's efforts on NASA's Saturn booster is one of the most complete accounts of this developmental project we have to read.

Again, our thanks for sending this copy of A&M. We hope you will be getting down this way again and will come over and see some of your old friends.

Orville S. Splitt, Director
Office of News Services
Department of Defense

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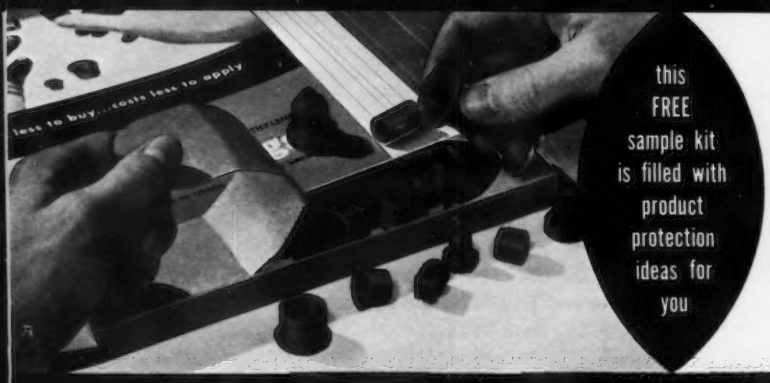

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Scientists and Engineers are cordially invited to write: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 3904, 2413 N. Hollywood Way, Burbank, California.

LOCKHEED

CALIFORNIA DIVISION

WE'RE CLOSER THAN YOU THINK...

Reading clockwise: Venus, Moon, Mars. Approximate distance from Venus to Earth, 25,000,000 miles; from Moon, 240,000 miles; from Mars, 50,000,000 miles.

Photos courtesy of Mount Wilson and Palomar Observatories.

Projects

AEROSPACE DATA CAPSULE I

MISSILES AND SPACE VEHICLES

NUCLEAR ROCKET--Proposals for R & D on a nuclear rocket engine are now being considered by the AEC-NASA Nuclear Propulsion Office. Contract will be awarded for first phase of program including preliminary design of the flight engine and formulation of an engine development program.

F-1--Rocketdyne's Prototype thrust chamber has reached 1,550,000 lb thrust in two-second static firing. Complete rocket engine is scheduled to be fired later this year. Preliminary flight rating tests will begin in 1962.

DYNA-SOAR--Air Research and Development Command brands a Senator's report of an early Dyna-Soar acceleration decision as "completely incorrect." The Senator said Lt. Gen. Bernard Schriever would make a decision by early March on a request by the Dyna-Soar project office to speed up the Boeing program for a possible manned orbit by 1963.

The Facts: The Dyna-Soar Weapon System Projects Office has been running a series of programs to determine what could be done if certain sums were made available. These reports had not reached Gen. Schriever in early March. Any congressional decision on added funds is not expected before April or May.

Escape Mechanism will be incorporated in tail-end of Dyna-Soar vehicle. This solid-fueled rocket will use spherical container (believed about four to seven ft long) and rocket nozzles. Rocket is not officially a third stage on Titan II.

Temperature-sensing for Dyna-Soar will be undertaken by Advanced Technology Labs. Prototype system, being developed under Boeing subcontract, will measure temperature at surface of glider's skin panels and leading edges.

Tests from B-52 will precede Dyna-Soar flights with Titan II booster.

MERCURY--First manned Redstone shot may occur early this month.

Capsule No. 14, fired in March, was last scheduled Little Joe flight. Purpose: test the capsule under highest dynamic loads it would receive under an abort during Atlas firing.

NIMBUS--First two Nimbus satellites (being developed for NASA by a team headed by General Electric) will be able to photograph entire globe every 24 hours from polar orbit. Command and receiving station will be built in Alaska.

APOLLO--Mid-study reports have been turned in by the three competing teams (Convair, General Electric, and Martin). Primary emphasis is centered on lens-shape glide vehicle configuration and on an advanced mercury ballistic configuration. Preliminary mockups are being built.

PERSHING--Test firings of two-stage Pershings from mobile field units have proven out the missile's tactical inertial guidance system.

X-15--Research flights of North American's X-15 are now scheduled to take place on a weekly basis with XLR-99 powerplant developed by Reaction Motors Div., Thiokol Chemical Corp. Climatic ballistic flight to 100 miles high and 4000 mph is slated for this year.

Temperatures encountered in flights are expected to rise to 700 deg F, well below 1200 deg F design temperature.

Records falling: Speed record of 2905 mph (set March 7) is expected to be soon exceeded.

SCOUT--NASA expects to have improved versions of Scout's third and fourth stage rocket motors by early next year. New solid propellants will increase payload capacity by about 40 per cent.

Projects

AEROSPACE DATA CAPSULE I . . . continued

POLARIS A-2--Slated for its first undersea launch this month from the submarine "Theodore Roosevelt." It has already been fired from a ship--the USS Observation Island on March 2.

New Second Stage Rocket Motor on A-2 is a big factor in increasing range 300 miles over A-1. Motor was produced for Navy by Hercules Powder Co. at the Allegheny Ballistics Laboratory. It utilizes lightweight case comprised of 267,930 miles of continuous glass filament.

SUBROC--Initial underwater firings expected to be completed in June.

MINUTEMAN--Construction is now beginning on the first hardened Minuteman base at Malmstrom AFB, Mont. It will include 150 silos.

SATURN--First of ten R & D flight tests of the C-1 Saturn vehicle is scheduled for late this year. It will have a "live" S-1 booster of eight clustered Rocketdyne H-1 engines, dummy S-1V second stage, and dummy S-V third stage. Same vehicle is to be fired twice in 1962.

First Three Stage C-1 flight test with all live stages is scheduled for 1963, and first operational firing for 1964. Static testing of first 1.5-million-lb-thrust Saturn flight booster is scheduled for this Spring.

AIRCRAFT

B-52H--Initial deliveries to SAC's Wurtsmith AFB begin next month. Produced by Boeing-Wichita, B-52H Stratofort can surpass B-52G's 10,000 mile range. It made its initial flight with Pratt & Whitney TF-33 turbofan engines (17,000 lb thrust apiece) on March 6.

Skybolt-Stratofort combination is to be operational in 1964 after compatibility testing at Boeing-Wichita.

Last B-52G has been produced.

RYAN VERTIPLANE--Beginning a new NASA flight test program at Moffett Field.

B-70--First flight test of prototype slated for late 1962. Lockheed-Georgia, producing the upper intermediate fuselage under subcontract to North America Aviation, reports that first of 30 brazing fixtures for bonding stainless steel honeycomb are now being produced. These ceramic and steel tools will subject the honeycomb layup to temperature extremes from 1700 deg F to —100 deg F.

Escape System for B-70 has passed a series of rocket sled tests at Hurricane Mesa, Utah. In emergency, crewmembers' seats convert into capsules which can be rocketed through escape hatches.

LAST OF THE VOODOOS--Being produced at McDonnell Aircraft's plant. The F-101 has accounted for $1,103,027,-941 in contracts since work began in January, 1952.

CHINOOK--Vertol Div., Boeing Airplane is tooling up for quantity production of the HC-1B twin-turbine Chinook. Its cargo compartment can carry a three ton load. Deliveries to the Army begin next March.

MOLECULAR RADIO RECEIVER without tubes, transistors or conventional circuit has been built by Westinghouse to illustrate principle of molecular electronics.

FIRST SABRELINER T-39B--Now operational in the Air Force.

MISSILEER--Reportedly being considered for ASW missions.

VTOL FIGHTER--Proposals on a VTOL aircraft to operate from unprepared sites and amphibious assault ships are due next month. The Bureau of Naval Weapons, acting as development agency. invited proposals from about 30 potential contractors. Contractor will be selected by July.

Winner of the design competition will produce a small number of VTOL's for operational suitability testing under the program which is jointly and equally funded by the three services over a four year period. The VTOL is to have 300-400 knot max speed at sea level with ten minute hovering capability.

Technical Advances

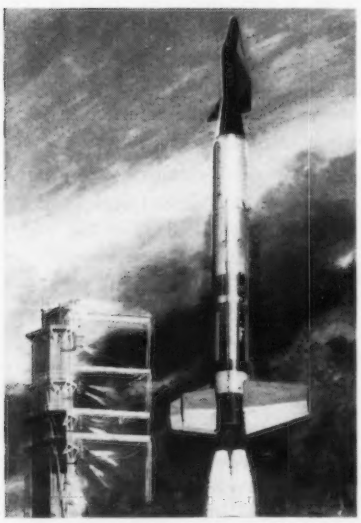
AEROSPACE DATA CAPSULE 2

Five-ton Soviet satellite orbited and recovered on March 9 was fourth of its kind to be launched since last May. "Chernushka," a dog, was reported as well after orbiting in the spacecraft which landed on command in the landing area.

Prototype of "electrically suspended gyroscope" (ESG) had been produced by Minneapolis-Honeywell. ESG, scheduled for use in the Polaris submarine navigation system, suspends gyro's spherical rotor in electric fields.

Perceptron study, conducted by Cornell Aeronautical Laboratory for the government, has yielded proofs for a number of theorems of fundamental importance to the theory of such electronic nerve networks. Researchers concluded that problems "involving wide variations in frequencies and sizes of stimuli in an environment, are shown to be soluble."

Synchrolink digital telemetry system, under development at General Electric (MSVD), would reportedly triple the range of present telemetry from space vehicles.



DYNA-SOAR shown is first artist's conception. Note finned Titan II booster and winged glider. Latter will make controlled flight.

Bell Aerosystems recently unveiled its 2000-lb experimental air cushion vehicle. Powered by a 66-hp auto engine, it operates about three inches above ground, can reach 15 mph with three passengers.

Space vehicle simulator is in use at RCA's Missile Electronics and Controls Div. for studying techniques of space rendezvous and guidance. Platform mounted on a near frictionless air bearing holds weights which match the mass distribution of the vehicle.

External cargo swing has been developed by Vertol Div. of Boeing Airplane for installation underneath helicopters. Device locates suspension point near the 'copter's CG.

ICBM operational readiness can now be tested with an automatic electronic analyzer called D-PAT. Developed by Hughes Aircraft, it uses a digital computer and magnetic memory drum.

Segmented rocket engines now under development at United Technology Corp. could reportedly place thousands of lbs of payload into orbit.

HUL-1M, first aircraft to fly with Allison T63 engine, is being readied for Navy evaluation flights. It recently completed 20-hr tie-down run.

Helicopter rotor blade which was entirely of glass fiber was used in flight for the first time recently with a Kaman H-43 'copter. Firm reports "significant improvement in rotor blade fatigue resistance" with major savings in manufacturing and maintenance costs.

New solid propellant was used in a 38-inch-diam. rocket motor which was successfully test-fired at Rocketdyne's McGregor, Texas facility. Motor contained 3500 lb of the advanced propellant, which belongs to new Flexadyne family. Firing was at —75 deg F.

"Vocoder" device built for ARDC by Hughes Aircraft condenses a voice by ignoring redundant sounds. Using a narrower than usual frequency band, it is designed to relieve crowded radio channels.

Weightless experiments by Air Force have included putting magnetic sandals on four airmen. When they were weightless on a C-131b aircraft, the men walked in an almost normal fashion on the ceiling. Subjects reported the spatial orientation of "down" being where their feet were. Air force will conduct further experiments with shoes fitted with electromagnets.

Radioactive rocket fuel is being studied by the Air Force. Radioactive Carbon 14 was added to UDMH propellant by Tracerlab Inc. This helped an urgent medical effort to gather data on the compound's metabolic fate in the human body.

Environmental control systems for space vehicles — Three-year study at The Garrett Corporation's AiResearch Manufacturing Co. Contract awarded by North American's Space and Information System Div. Program will include primary analytical research and basic laboratory experiments of new concepts.

High-thrust vehicle studies— NASA has awarded three parallel six-month contracts to Convair (San Diego), Lockheed (Georgia) and North American Aviation for comprehensive studies of possible space vehicles beyond the Saturn class.

Harmonic Drive—Kaman Aircraft is studying a revolutionary power transmission system for possible applications to helicopters. Called Harmonic Drive, system was originally developed by the United Shoe Machinery Co.

Technical Advances

AEROSPACE DATA CAPSULE 2 . . . continued

B-70 will use the first motor-powered electrical throttle system to be used as a primary control in an aircraft. Motor can operate from 550 deg F to minus 65 deg F. It makes use of a unique aluminum anodizing method for insulation.

Airplane spinner on a recently-introduced Grumman model is reinforced with epoxy plastic. This adds service life to the units. (Spinners, protection housings covering the hub of the propellers, suffer from severe vibration as they revolve with props.)

New analytical method for determining the compressive strength of metal columns at high temperatures has been developed by Battelle Memorial Institute. Method is based on short-time stress-strain properties of materials. It makes it possible to predict the stiffness of columns under conditions encountered by missile structures.

NIKE ZEUS advanced configuration shown before R & D firing test at White Sands. Note forward control fin surfaces on third stage.

Screw-measuring device invented by two Huntsville, Ala. employees permits a missile maintenance man to measure the pitch diam. of screw threads with one hand. Patented device fits on a standard micrometer caliper. Inventors are Linwood Varney of the Army Ordnance Guided Missile School, and Stanley Farrow, of Emerson Radio & Phono. Corp.

Air-lubricated bearings developed by Chrysler's Missile Div. have potential as space vehicle lubricants. Hydrodynamic type can be exposed to operating temperatures ranging from —300 deg F to 2500 deg F. Hydrostatic bearing, a second type, is made from special porous sintered powdered metal through which pressurized air is used to form a film.

Plastic lathe cup in use at Taylor Fibre Co. holds concentricity to .001 inch tolerance in machining internal diameters to round parts made of laminated plastic.

USAF machinability report, entitled "Machining Characteristics of High Strength and Thermal Resistant Materials," now expanded by a fourth volume developed by Metcut Research Associates. Available through Manufacturing and Materials Technology Div., AMC Aeronautical Systems Center, Wright-Patterson AFB, O.

High-energy solid propellant rocket motor using titanium motor case was recently static-fired by the U. S. Army Ordnance Missile Command at Huntsville, Ala. Case, designed jointly by Pratt & Whitney Aircraft and the Redstone Div. of Thiokol Chemical Corp., was called "the highest performance metallic propulsion unit pound - for - pound ever successfully fired in the U. S."

Algae pool at General Dynamics Corporation's Electric Boat Div. holds 1200 gallons. Algae is produced by circulating chlorella cultures around underwater fluorescent lights in the presence of carbon dioxide and a nutrient medium.

Pilot's microphone utilizing a revolutionary new principle will be developed by CBS Laboratories. Firm will design new acoustic and electrical equipment to provide more reliable and simplified connections to wiring terminals from helmets, pressure suits and ejection seats.

Stress-analysis of elastic shells can now be shortened by a general shell computer program developed by Arthur D. Little Inc. Program applies to any shell of rottaional symmetry. It reduces analytical time to a few minutes.

New 5000 gpm LOX filter cleans fuel in rapid propellant loading system in use at Martin-Denver. Filter was designed and built by Bendix Filter Div.

Titanium fittings can be manufactured at one half normal costs with precision cold extrusion techniques developed by Battelle Memorial Institute for the Air Force.

Electro-spark forming of refractory metals may save millions per year in metalworking costs. Under development at General Electric's General Engineering Laboratory, process directs high-intensity shock waves against metals such as titanium, niobium, and tungsten.

New dual research program is underway at Metallurgical Products Dept., General Electric Co. One group will investigate new and improved hard materials and means of improving manufacturing processing. Other will study anticipated industry needs for Carboloy products in tools.

Minuteman data display system was recently delivered to Boeing Airplane by Radiation Inc. for use during static and flight firings. Called a "Raster Display," this advanced system presents vital data in simplified bar graph form on the face of a cathode ray tube.

New Books

AN INTRODUCTION TO THE THEORY OF AIRCRAFT STRUCTURES. By D. Williams. St. Martin's Press, 1960. 448 pp., $15.00. Material presented in this book is partly based on weekly lectures given to post-graduate students in Aeronautics at Imperial College (London University). It therefore presumes a grounding in basic engineering, physics, and applied mathematics; the elementary theory of beams is assumed by the author to be already familiar to the reader. Chapters are devoted to the following aspects; stress strain and displacement relations, strain energy methods, examples of the use of energy methods, method of individual displacements, solutions by successive application and removal of constraints, torsion of shells and box-beams, bending shear in thin-walled beams, shear-lag, pressure-cabin problems, dynamic and impulsive loads, dynamic loading of aircraft, natural frequencies and modes of a complete airplane structure, and instability of motion.

WHO BUYS WHAT IN THE MISSILE & SPACE INDUSTRY. Innovators, Inc., 1960, $12.50. This is a directory naming the buyer of each commodity for every contractor listed. Through this directory, prospective vendors can contact the buyers concerned with particular categories of purchased items.

BASICS OF GYROSCOPES (In two volumes). By Carl Machover. Rider, 1960. Vol. 1, 101 pp.; Vol. 2, 114 pp. $3.30 per volume. Any non-specialist working with or interested in gyroscopes will find lucidly-illustrated explanations on the what, how and where they are used. Volume 1 discusses: what a gyro is, degrees of freedom, how it works, law of gyroscopics, precession, vertical gyro and its components, directional gyro, and gyrocompass. Volume 2 explains: the rate gyro, axis location, the integrating gyro, stable platforms, inertial navigation, measuring velocity, resolving acceleration, construction and applications. Review questions are provided at the end of each section to test comprehension.

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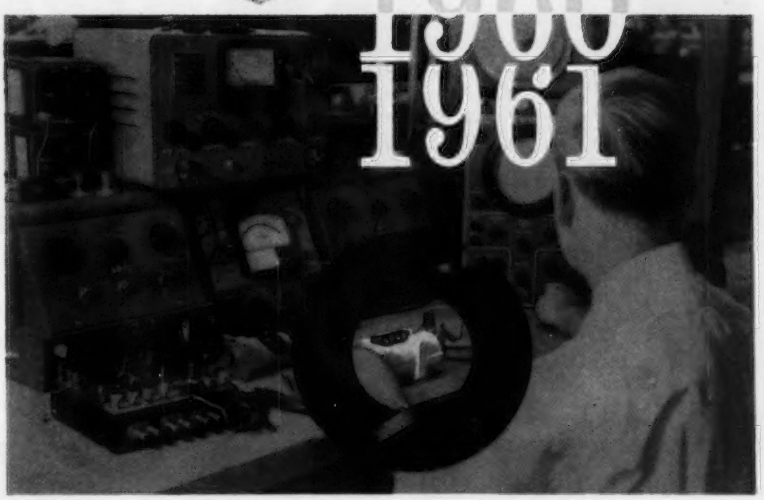

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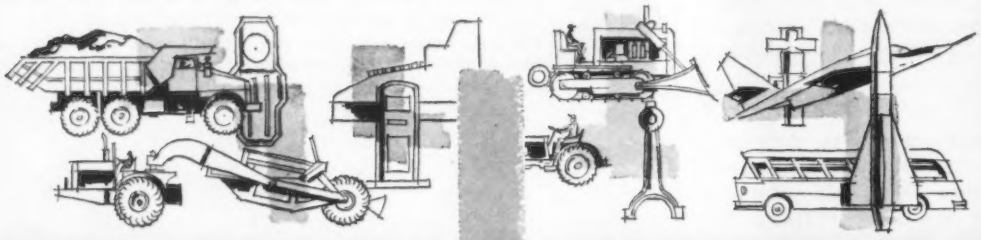

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Sizes: 1 ounce to 500 pounds

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FORGINGS AND DEEP DRAWN STAMPINGS

Procurement

AEROSPACE DATA CAPSULE 3

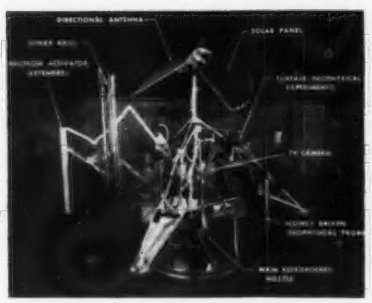
Business Moves

Space Technology Laboratories Inc. has formed a new division, STL Products, to commercially market scientific and technical devices developed from STL research in space with ballistic missile technology. New division this month places high-speed electronic camera and an atomic frequency standard on the market.

Kaman Aircraft Corp. and Grumman Aircraft Engineering Corp. are participating jointly in the Army's competition on design of a light observation helicopter. If Kaman wins the contract, Grumman will supply engineering and productive effort as well as facilities.

Monterey Research Laboratory, newly-incorporated subsidiary of Research Inc., will specialize in research, development and limited production of shock mitigation systems, space landing systems, compressible fluid devices, and electro-hydraulic and pneumatic devices.

Tenney Engineering's new Acoustics Div. is undertaking development of advanced sound-source machines for testing jet aircraft and rocket components and structures.



HUGHES AIRCRAFT won NASA contract this year to build seven of the lunar-soft-landing Surveyor spacecraft. Full-scale model is shown at Cal Tech.

Facilities

Amcel Propulsion Inc. has built a reinforced concrete facility with eight "high energy cells" to extend scale-up capabilities for hazardous materials. Equipment will be used for developing, machining and other operations with propellants and explosives. New static test stand, also at the Asheville, N. C., site, can test fire 500,000-lb-thrust rocket motors.

The Garrett Corp. recently expanded its Phoenix plant by acquiring 24 acres of land and a 60,000 sq ft office-factory building. Acquisitions are to facilitate expanded work in nuclear and solar power for space vehicles and turbine-generated power for missile systems.

A. Biederman Inc. is now doing specialized missile work in addition to its established service in maintenance and calibration of precision aircraft instruments and navigational systems. Missile components can now be serviced in firm's new dust-free "white room."

General Electric Co. has doubled its planned investment in its Valley Forge Space Technology Center, now a-building and slated for completion by the end of the year. The space facility will cost $30-million instead of the $14-million originally planned. It will include a $6-million space simulator to test full-size space vehicles.

Aerojet-General Corp. is constructing a $1¼-million facility at its Azusa plant to test and manufacture infrared subsystems for the Midas satellite. Test program will subject units to intense heat, cold, and vibration.

The Bendix Corp. will be able to test complete spacecraft in a large vacuum test chamber to be completed this October at the Bendix Systems Div.

Contracts

Raytheon Co. — $28,177,129 for production of the Navy's Sparrow III missile system.

Vertol Div., Boeing Airplane— $25-million to produce 18 additional HC-1B Chinook medium transport helicopters for the Army; delivery in 1962.

General Electric Co. — $28-million to develop the Mark 6 re-entry vehicle for the Air Force's Titan II missile.

AC Spark Plug — $20-million released by the Air force to design, develop and integrate an improved radar bombing navigation system (BNS) for B-52 aircraft.

The Garrett Corp. — $18-million in total contracts for environmental equipment and central air data systems to be installed on Lockheed F-104 Starfighters ordered by six foreign nations.

The Martin Co. — $14-million for additional production of Bullpup Missiles.

Pratt & Whitney Aircraft—$9-million Navy follow-on to develop the TF-30 turbo-fan engine.

The Western Electric Co.—$6,-200,000 for Nike Hercules equipment.

Sperry Utah—$4-million from the Army for Sergeant work.

AVCO CORP. reports that Minuteman's Mark 5 re-entry vehicle, being developed under Air Force contract, will soon enter production.

Said Gaspard de Coriolis: *"A particle which is subject to no forces in a rotating coordinate system experiences a radial acceleration and a tangential acceleration."*

It was around 1840 that Coriolis discovered what has since become known as the Coriolis Effect. He noticed objects above the earth tend to rotate relative to the earth's rotation . . . to the right in the northern hemisphere, to the left in the southern.

The Coriolis Effect is in force in outer space, too. If a space vehicle is rotated in order to establish artificial gravity, the necessarily short radius of the rotation causes a Coriolis force. This creates orientation problems for a human occupant. To eliminate this difficulty, a scientist at Lockheed Missiles and Space Division conceived the idea of connecting the vehicle to an auxiliary fuel tank by a half-mile-long cable. Thus, if the whole system is then rotated at a reduced speed around its center of mass gravity, the longer radius greatly minimizes the Coriolis force. Right now—on the drawing boards at Lockheed—is an enormously advanced space vehicle system which utilizes this concept, in addition to many others.

Fortunately, natural laws are about the only restrictions which circumscribe scientists and engineers at Lockheed Missiles and Space Division. The climate in Sunnyvale and Palo Alto, on the San Francisco Peninsula, is close to perfection. The creative atmosphere—the opportunity to work on such important projects as the DISCOVERER and MIDAS satellites, the POLARIS FBM, or even more advanced concepts such as the space system cited above—is the dream of the creative engineer.

Why not investigate future possibilities at Lockheed? Write Research and Development Staff, Dept. M-11B, 962 West El Camino Real, Sunnyvale, Calif. U.S. citizenship or existing Department of Defense industrial security clearance required.

Lockheed / **MISSILES AND SPACE DIVISION**

Systems Manager for the Navy POLARIS FBM and the Air Force AGENA Satellite in the DISCOVERER and MIDAS Programs

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

Market Planning

AEROSPACE DATA CAPSULE 4

Aerospace Industries' New Market In ASW

Polaris and Naval Aviation have allied ASW technologies with the aerospace industries. There is a giant new market developing and it's not too late to get in. The propulsion, dynamics, materials, and electronics know-how of many firms now doing aerospace business is needed to solve the puzzle of coping with a fleet of unfriendly nuclear submarines.

The market is now estimated at $1.5 billion. Prospects are for a rapid rise to $2.5 billion. Request for the new funds is based on insuring our free use of the seas. About 99 per cent of all our export-import tonnage travels by sea.

Most of the expected $1.0 billion increase will go to developing fast ships, but there will be enough spill-over into electronics, and propulsion to stimulate the aerospace-related market.

Aircraft, and related procurement account for about 20 per cent of the current ASW spending. Lockheed & P3V, Grumman's S2F-3 and Sikorsky's SS-2 get the greatest part of this ordnance and ammunition, mostly nuclear devices, ASROC, ASTOR, and homing torpedoes account for 4 per cent.

Over 17 per cent of Navy's $1.3 billion RDT&E budget is related to ASW. The bulk of the money is directed in four areas: (1) detection and localization 30 per cent; (2) ordnance and fire control 25 per cent; (3) propulsion and structures 15 per cent; (4) data correlation display and support equipment about 10 per cent.

Research & Development—There are over 100 ASW research projects now active. Half are concerned with acoustics and oceanography. Increasing acoustical detection ranges is the main concern. Most of the sonar equipment now aboard surface ships has an effective range measured in yards, not miles. The killer submarines reportedly will have sonar with 20 to 30 mile range but the ability to sort out false alarms is not known.

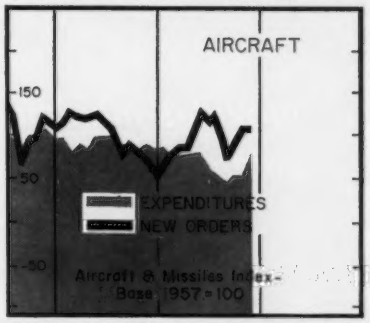
An increase in oceanographic research is expected in fiscal 1962. More knowledge of the deep-sea environment is needed before new equipment can be designed to operate in it. About $17.7 million, was allocated in fiscal 1961, an increase from $14.4 million in fiscal 1960. A corresponding increase is expected in the current fiscal year.

Special Ships—High speed surface craft and hydrodynamic studies are currently drawing $10 million. The success of the Maritime Administrations 80 ton hydrofoil due for launch in June, and the 110-ton subchaser being built at Boeing could create a revolution in ship design.

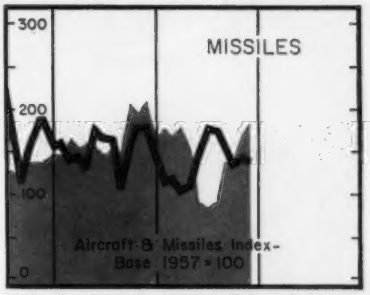
Forty eight and six tenths per cent of the total ship building and conversion budget presently is concerned with vessels that have an ASW mission. In the FRAM (Fleet Rehabilitation and Modernization) program, 710 class destroyers are being equipped with DASH, long-range sonar, ASROC, and other devices at $10.2 million each.

DEFENSE EXPENDITURES AND NEW ORDERS

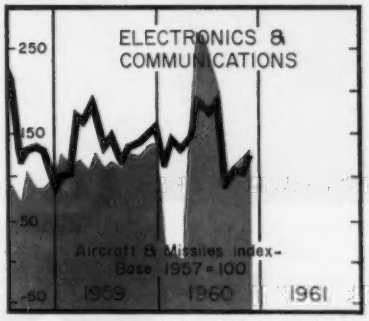
3 Months' Moving Average Index



Aircraft includes air-frames, engines armament, electronics, and other government furnished equipment. Also included: special tools, test equipment, and ground handling equipment.



Missiles graph includes complete missile systems—armament, launching, guidance, control, boosters, sustainers, propellants, special tools, and ground handling equipment.



Electronics and communications graph is related to the following equipment: radar, eletromagnetic equipment, computers, radiation airs, countermeasures, radiac and infrared, meteorological equipment, sonar, transmission or reception units, noise and interference detection devices, test equipment, spares, and related component equipment.

AiResearch pressure suit cooling unit

provides maximum pilot comfort on the ground

This portable, lightweight package keeps the pilot cool and comfortable on the ground in his flight pressure suit from one to two hours. Utilizing cryogenic liquid oxygen as the coolant, it requires no electric power or other connecting supplies which might hinder the pilot's mobility.

Easily carried by hand or slung from the shoulder, the AiResearch unit can cool a pilot wearing either full or partial pressure suit during travel to and from his aircraft, preflight checkout and while seated in the cockpit. Pure oxygen for prebreathing can also be provided as a simultaneous function.

This extremely simple and reliable cooling unit has no moving parts. In operation, ambient air vaporizes a supply of liquid oxygen to pressurize the system. Cooling air, made up of stored oxygen and ambient air, is then circulated through the suit.

AiResearch is also in production on self-contained life support systems inside fully enclosed protective suits. These suits allow the wearer to work safely in hostile environments such as toxic missile fuel handling and fire fighting. Research for modification of these systems is now being conducted for space use.

• *Please direct inquiries to Los Angeles Division*

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

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Systems and Components for: AIRCRAFT, MISSILE, SPACECRAFT, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

Management

AEROSPACE DATA CAPSULE 5

Broad-based ASW Program

Chance Vought's ASW program covers activities in all five divisions of the firm: Aeronautics, Electronics, Range Systems, Astronautics and the Research Center. A Corporate Director of ASW Engineering, Vice Admiral Harry Sanders, USN (Ret.), directs the program.

The Dallas, Texas, firm has been working on a second generation carrier-based ASW aircraft for over two years. Basic approach: design the airframe, ASW electronics equipment, weaponry, navigation and other sub-systems from the beginning on the weapon systems concept.

Centralized ASW Group

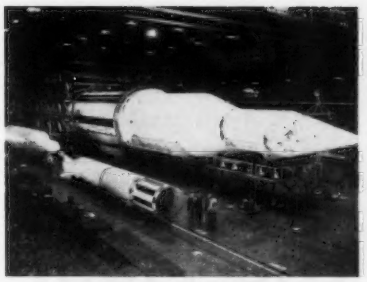
Lockheed Aircraft has concentrated management of ASW R & D in a highly-specialized group designated LAWSO (Lockheed Antisubmarine Warfare Systems Organization). Group varies from 12 to 25 experts as specialized investigations are undertaken.

Air Force Wins Management Battle

The Air Force has been given responsibility for R & D on military space projects. The Navy and the Army will not develop their own space projects.

The Pentagon management shakeup was ordered by Defense Secretary McNamara. He acted on advice from the newly-created Office of Organization and Management Planning.

SATURN C-1 flight configuration. NASA, Douglas, and Convair are managing development of the three stages. Juno II and Mercury-Redstone shown in foreground.



Value Analysis Group

Sikorsky Aircraft recently conducted a day-long cost symposium. Entire HSS-2 team was represented. Rear Adm. W. A. Schoech, deputy chief of the Bureau of Naval Weapons, told the group they should "resist pressures from your and our engineers and from our requirements people to move in the direction of more complexity."

The move towards complexity, he added, is prompted by a desire to increase weapon effectiveness but "in very many cases we realize 10 per cent increase all right but we pay for it with a 50 per cent decrease in reliability and a 100 per cent increase in cost."

The watchword of the Resistance, the admiral stated, is "KISS"—"Keep It Simple, Stupid!"

MANAGEMENT QUOTES

The following statements were made in testimony before the House Committee on Science and Astronautics:

Dan A. Kimball, president, Aerojet-General Corp.: "(We should) immediately undertake the development of very large solid booster rockets of the segmented principle. . . . (We should) augment present development work on large, highly efficient pump and pressure-fed liquid rockets. . . . There is an urgent need for an engine using high performance liquid hydrogen-liquid oxygen propellants to power the second stage of (such a) booster for a lunar mission."

R. L. Johnson, chief engineer, Missiles and Space Systems, Douglas Aircraft Co.: ". . . a reusable system leads to very low cost space transportation and is the real reason for constructing nuclear space transports."

L. E. Root, group v.p., Lockheed Aircraft Corp.: "Initial flights (of a nuclear third stage on Saturn) in the 1965 to 1966 time period are attainable."

Dr. Harold W. Ritchey, vice president, rocket operations, Thiokol Chemical Corp.; "To use a rough measure, it is estimated that all the effort expended by industry (on the nuclear rocket) during the past five years, in terms of expenditures, is perhaps only 10 per cent of the effort that will be required by industry during the next five year period."

J. R. Dempsey, vice president, Convair Div., General Dynamics Corp.: "Our objectives for the technical plateaus should go something like this: First (the period into which we are now just entering), capability for orbital payloads in the region of 20,000 to 30,000 lb; second capability for orbital payloads of 200,000 to 250,000 lb, corresponding to parabolic capability of 150,000 to 200,000 lb . . .; third, lunar base capability (when) we can expect to be making several hundred launches per year. . . ."

A MANAGEMENT PROBLEM

Purchased parts and components give missile makers reliability headaches. Some makers have gone to great lengths to cure ills; others are deficient. The author lays it on the line in analysis of eight major companies. Since he is with a prominent maker, he calls other firms A, B, C, etc. Some you will recognize; one might be yours.

The Fight for Purchased-Parts Quality

Lay down reliability law to vendors; Enforce it by constant product tests

by G. M. Ellis, Project Coordinator
Quality Control Dept.
Convair/Pomona

Adequate control of the quality of purchased parts and components presents a serious and continuing problem to every missile manufacturer. The many instances in which missile tests have failed to achieve their objectives are amply evidence of the urgent need for better reliability. There have been special studies by Congressional committees (you can't legislate reliability) and by numerous technical and professional groups. Missile manufacturers have organized special departments and sections within their engineering, manufacturing and quality control functions to study, predict, measure, and control the reliability of their missile systems.

QAET Program Convair/Pomona

Parts and components used in Terrier/Tartar missiles are purchased to existing mil-specs if adequate to provide satisfactory items under missile operating conditions and environments. If there is no suitable mil-spec, an appropriate "ordnance specification" is prepared and invoked in the procurement of the item.

In order to gain increased assurance that the parts and components conform to environmental requirements, Convair/Pomona conducts a Quality Assurance Environmental Testing (QAET) program. Samples are taken from received lots of puchased parts and components and subjected to certain critical tests under specified extremes of environments. Items selected for testing are based upon their critical flight operating conditions and environments, prior experience, service history or similar items, and the results of initial evaluation and qualification tests. Typical parts subjected to QAET are: resistors, capacitors, transformers and reactors, relays, vacuum tubes, transistors and diodes, gyros, accelerometers, hydraulic valves, motors, pumps, etc. QAET is generally completed before purchased parts or components are released for production use. However, due to tight production schedules, many lots of purchased items are released to production before QAET completion.

In the event of failure of a QAET sample, the nature of the failure and its possible effect on missile flight performance is thor-

oughly examined. Significant failures are reviewed by the QAET Coordinating Committee — composed of people from engineering, material, manufacturing, and quality control. This committee decides on and initiates corrective action.

Unacceptable parts not released for production are often returned to the vendor for replacement. If non-conforming parts have been released to production, the rework of sub-assemblies, and possibly retrofit of delivered missiles might be included in the corrective action. In any event, suppliers are informed of any significant failures so that manufacturing processes may be corrected and the quality of the item maintained in conformance with requirements.

The effectiveness of QAET is proved by the greatly reduced rate of rejection of electronic parts that were QAET tested in a recent missile program. In an earlier program, about six per cent of all "lots" of purchased electronic parts were rejected, while in a more recent program in which comparable quantities of similar items were tested, the QAET "lot" rejection rate was only about 1½ per cent.

Company "A"
A Military Equipment Manufacturer

In most instances, Company "A" buys electronic parts to mil-specs. Very few company specifications are written for such parts. During procurement negotiations, Company "A" attempts to impress its vendors and subcontractors that compliance with all specification requirements is mandatory. Also, acceptance of tendered items is contingent upon successful passage of specified acceptance inspection tests.

A quite extensive and well-equipped environmental test lab is operated by what ordinarily would be considered "receiving inspection." Purchased items are not accepted for production use until all inspections and tests, including environmental tests, have been passed. In the event of parts shortages that would stop or jeopardize production, exceptions are made. All parts released for production before completion of environmental tests are specially identified. Thus, if sample parts fail to meet all requirements, those parts already on the production line or in assemblies can be readily located and removed.

Destructive tests (under extremes of environments) are not performed on every "lot" of parts received. Generally, these tests are performed on samples from every fourth "lot." In the event of failure of the sampled "lot," further testing is performed on samples from the three previous "lots" in order to determine the quality of parts in all "lots."

Diligent efforts in the past three years to impress vendors and subcontractors that all specifications requirements must be met, together with comprehensive acceptance inspection and testing, has led to a drop in rejections. Items failing to pass acceptance tests have dropped from about 30 per cent to about 15 per cent of all "lots" received. Rejections for failure to pass required environmental acceptance tests were reduced to approximately three per cent of all "lots" received. Company "A" believes that its efforts have been fairly successful in enabling it to purchase parts and components that meet procurement specifications.

Company "B"
A Missile and Military Equipment Maker

During the past few years, Company "B" has established a program to educate its vendors and subcontractors toward better quality control. There has been an extensive effort to impress upon vendors that specified requirements for performance under extreme environmental conditions are necessary, reasons why such specification requirements exist, and that furnished items must conform to all such requirements.

Company "B" has had a program generally similar to QAET on parts and components. Samples of received "lots" of parts are subjected to environmental tests to determine conformance to specifications and acceptability.

Considerable improvement in the quality of purchased parts and components has resulted from this aggressive program. Failures of purchased items to pass acceptance tests have been at the rate of eight per cent of all "lots" received.

Company "C"
A Missile Manufacturer

This company is not engaged in high volume production. Parts and components are being procured in relatively small quantities, usually to mil-spec. Due to the smallness of the quantities purchased, procurement often is from parts jobbers and distributors rather than from parts makers.

The details of Company "C's" policy and program of testing purchased items for conformance to specification requirements under extremes of environments were not determined. However, the company does use acceptance inspection tests, including tests under environments, to determine acceptability of parts.

Many items procured from parts jobbers and distributors failed to pass acceptance tests and were rejected to the supplier. As a result, there have been many problems between Company "C's" quality control, inspection, engineering, and purchasing departments, and the vendors. Acceptance-inspection rejections rates have been approximately 40 per cent of all items received.

Company "D"
A Missile Manufacturer

Company "D" does not have a program directly comparable to QAET for purchased parts. A function somewhat similar is more of a pre-production testing program. Only the first "production" articles are inspected, tested and evaluated. It was generally agreed by Company "D" representatives that the absence of a QAET-type program is

Importance placed on supplier's classification rather than the lowest quoted price

a serious deficiency in its quality control and reliability system.

Environmental testing of parts is done only if parts fail during production testing, subsequent operation, or testing of the assembly in which the part is used.

Company "D" has a QAET-type program, although, for the environmental testing of components. A reliability engineering group reviews both the "end item" specifications and the component specifications. It then selects critical characteristics for special environmental testing procedures. Because of relatively small-quantity production and high unit cost, usually only one sample per received "lot" is subjected to environmental tests. In the event of failure of the item, one or more additional units are subjected to only that portion of the test in which the original sample failed. It is then determined if the failure is characteristic of the "lot."

Accurate information is not available on the rate of failure of components to pass the special environmental tests. Estimated failure rate is between 30 and 60 per cent, probably being close to 50 per cent.

Company "E"

A Missile Manufacturer

Company "E's" missile program was estimated, bid, and contracted several years ago. Many of the now obvious reliability and quality problems with purchased parts and components were not then known. Consequently, there is no formal program for environmental testing of parts procured for production.

Through an initial parts testing activity, Company "E" "qualifies" parts and approves suppliers. Procurement specifications invoked are either mil-spec or company modified mil-specs.

Purchased parts and components are accepted solely upon satisfactory passage of "Group A" type acceptance tests. Environmental testing is done only when trouble is indicated by excessive failures in receiving inspection, production inspection and testing, or in a special "technical review" program.

The "technical review" program performs a quality audit of the manufactured product. By a rotating sampling plan, one of the various functioning sub-assemblies or packages is taken from every third unit manufactured. Items are subjected to exhaustive examination and functional testing, including some environmental testing for critical characteristics. This rotating sampling plan checks all packages of which the end-product is composed. Results—an audit of the quality of the entire end product.

Company "E" manufactures almost all of its components and instruments. Thus, better quality control. However, gyros are purchased, and interestingly, each one is subjected to an extended-range temperature test as a part of the receiving inspection acceptance procedure.

Although no environmental testing program is contractually required of Company "E," environmental tests of purchased parts and components are being performed with increasing frequency. Company "E" bears the resulting costs. Bids made on new proposals include provisions for environmental acceptance-testing of parts and components.

Company"E" also manufactures missile field control and test equipment containing instruments that are commercial and proprietary in their basic design, but modified in conformance with special requirements. Typical instruments are signal generators, vacuum tube voltmeters, etc. A pre-production testing program is used to evaluate the first production unit procured. Testing under specified extremes of environments is usually a part of this first part evaluation.

Company "F"

A Missile and Aircraft Maker

Company "F" does not build electrical and electronic components and packages that are used in its missiles. Instead, these "black boxes" are subcontracted or government furnished. As a result, it does not buy electrical and electronic parts in big quantities. Consequently, it does not have a purchased parts quality problem of similar magnitude to that of most other missile makers.

At Company "F," considerable credence is given to what is called "product qualification." This means that the end product has been thoroughly tested and approved as meeting the requirements of the specification. Much more importance is attached to "product qualification" than to specific considerations of quality and performance of parts and components. The underlying philosophy seems to be: "If the bird flies, that is what really matters." Details of how well the various integral parts conform to their particular specification requirements is of lesser concern. Until there are significant failures in production test or flight, there is no need to look further at the quality of the parts and components.

Even though Company "F's" "black boxes" are subcontracted or government furnished, some parts and components are purchased for use in missile assembly. Acceptance inspection of these purchased items includes considerable environmental testing. The test plans and procedures used for acceptance tests are prepared under a design group, and contain requirements for testing under environments considered to be critical in relation to actual missile flight conditions. In an attempt to

get a measure of the percentage of rejection as a result of the environmental testing, it was learned that "—in the early stages of a program, it is quite high—sometimes as high as 30 to 40 per cent—20 per cent is not uncommon."

Production monitoring testing is an engineering department activity in which samples of production parts, sub-assemblies and assemblies are selected at sampling rates which have been arbitrarily established by the design group. Units are subjected to ambient and environmental tests. This testing program, together with the resulting data and reports of actions, is confined exclusively to the engineering department. Upon occasions, the quality control department has attempted to get production monitoring test data from engineering, but with no success. It seems that the desired data had been mislaid or lost, or the test had not been run, having been waived on the basis of existing high confidence in the item, or for other reasons. This program seems to have been very ineffective due to poor administration, but steps have been taken to more tightly control the program and increase its effectiveness.

Company "G"

A Critical Military

Equipment Maker

Company "G" is a prime contractor to an important national defense agency. Very little weapon manufacturing is done directly by the company. It does arrange for manufacture, both by its own suppliers and by the integrated contractors working for the same defense agency.

A large amount of "G's" effort is directed toward the development and manufacture of a family of weapons that can be stockpiled-sealed and which will require no field inspection or routine maintenance before use. Reliability of the weapon is a prime consideration.

Since Company "G" does very little manufacturing, comparison with others is difficult. However, some of its methods, activities and functions are of considerable interest, and in some ways can be related to like things at other companies.

Company "G" has not had an activity comparable to QAET on parts and components. However, the need for such a program has been recognized and planned organizational changes have included the establishment of a group for this specific purpose. Early development and start of such an environmental testing program is anticipated.

Considerable effort is expended in educating suppliers as to why high quality and reliability standards are needed, and how Company "G" operates to achieve these ends. Suppliers are strongly urged to thoroughly read and understand the specifications upon which they bid, and are also specifically told that once a purchase contract is in effect, the supplier is expected to comply with all requirements.

Company "G" specifications for components or "black boxes" contain requirements for inspection, testing, and quality control. In some cases these specifications require the supplier to establish inspection procedures and quality control systems to assure a high order of reliability. Also, the supplier is required to prepare and furnish written descriptions of assembly operations, process controls, inspection and quality control practices to be used. Points of inspection, sampling plans, functional tests (both non-destructive and destructive), etc., are specified. Shewhart control charts, such as X, R, and p charts for inspection and test data are required.

Parts are procured to either mil-spec, or to specifications prepared by Company "G."

In order to get some new quality control functions, a special group was organized. One of its activities is the use of statistical techniques to control the manufacturing processes of both the company and its contractors. Quality control charts prepared by both "G" and its contractors are monitored by this group to detect changes in processes which result in lower quality products.

This special group also handles vendor relations pertaining to quality problems. "Quality control teams" are provided to train suppliers in basic statistical quality control principles and to assist them in establishing satisfactory control systems. These teams usually consist of three persons, one from design engineering, one from manufacturing engineering and a quality control specialist.

Another vendor relation function of this group is their participation in vendor quality surveys. This is a team activity, with representatives from engineering, purchasing, and quality control.

The quality performance of all suppliers is continuously monitored. Through the use of an evaluation plan, all suppliers are classified into one of the following five groups:

Class A—Approved.

Class B—Satisfactory (may be used without restriction but engineering attention is required).

Class C—Marginal (will require engineering reevaluation and education before approval can be granted).

Class D—Approval contingent upon Committee action.

Class E—Disapproved.

Classification is done semi-monthly by a committee made up of the heads of engineering, purchasing, inspection, and production. **A supplier's classification is an important consideration in the placement of purchase contracts. The lowest quoted price is not the deciding factor, unless it is from a satisfactorily classified supplier.**

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BOEING / WICHITA

Airpower In Russia's Navy

**Soviets maintain over 3000 land-based aircraft;
Mission is to destroy 'enemy' Naval forces;
Polaris causes flurry of ASW activity**

SOVIET NAVY has used helicopters in utility missions for some time. ASW is a new task. An MI-4 Hound is shown picking up personnel from a W-class submarine. Hound carries 3527 lb and cruises at 99 mph. Range is 248 mi. Soviets have 120 W- class submarines. They are equipped with snorkel and some have missile hangers and launching ramps on deck.

Polaris has added new impetus to Russia's naval aviation program. The threat of missile-bearing nuclear submarines lurking in the cold, dark depths of northern waters has caused a particular flurry of activity in antisubmarine warefare (ASW). With increased frequency intelligence sources spot references in the Russian press to new equipment, and greater capabilities for the Soviet Navy. Some of this activity is real. Some is calculated to deceive.

The planes Russia holds to wage war against shipping are not carrier-based like our own. They are based ashore. Emphasis is on fighter defense and long range jet reconnaissance bombers to extend air coverage for the far-ranging Soviet submarine forces. Most equipment is not for specific naval requirements. Instead, Air Force equipment is used.

Naval aviation in Russia has had a spastic history. But, since about 1950 when the Soviet armed forces were de-unified and each service was headed by its own minister, the trend has been unmistakeably forward. The Navy now has about 3000 airplanes.

By the end of 1951, nearly half the fighter strength of Soviet naval

Helicopters given increased emphasis by Soviet Navy; Destroyers equipped with ramp to handle KA-15 Hen

aviation consisted of jets. Conversion was continuing at an accelerated rate. Bosuns and Beagles (IL-28) were incorporated as twin-jet light bombers, and mine/torpedo aircraft. Jet conversion in aerial reconnaissance was initiated. By the late fifties, Russian naval aviation was modernized.

In 1957 Air Marshall Vershnin wrote in Pravda: "The Soviet Navy is equipped with modern weapons and is capable not only of defending the sea frontiers of the state but also of destroying the naval forces of the enemy on seas and oceans and striking blows at targets situated in other continents."

Modernization continued unabated. New jet aircraft including Farmer (MIG-19) day fighters and Flashlight (YAK-25) all-weather fighters were introduced into naval units. The replacement of Fagots (MIG-15) by Frescos (MIG-17) and the all-weather Fresco-D fighter continued.

Naval units were pictured in the Russian press with the twin-jet bomber Badger (TU-16). It is assumed that this plane was adapted to such long-range missions as reconnaissance, anti-shipping, and coordination with submarines. The air-to-ground missile Komet had also been mentioned in connection with the Badger. The missile reportedly has a 50-mi range.

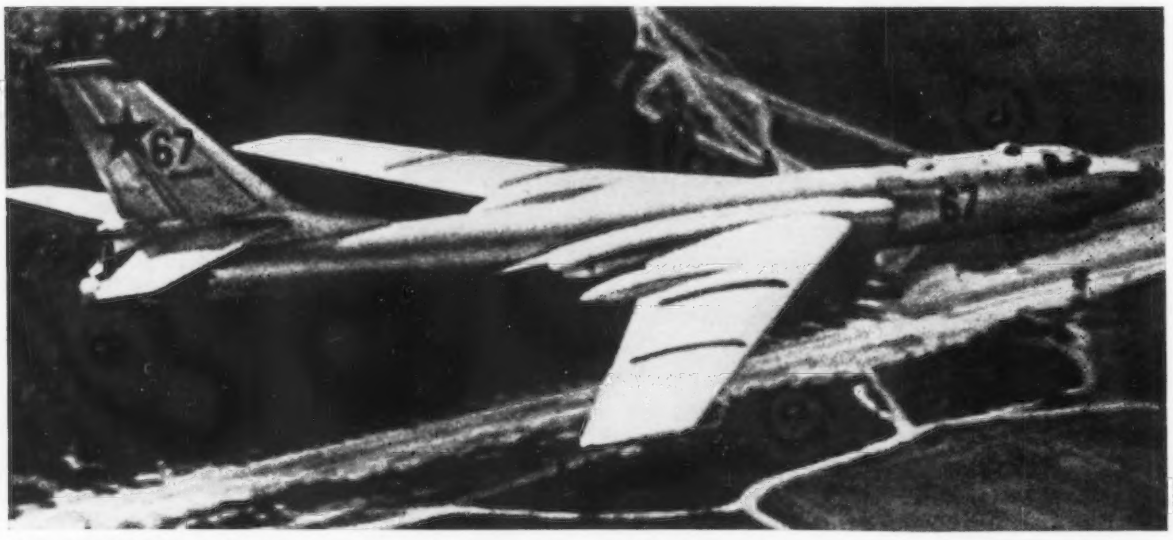
In view of the Polaris threat, increased interest in new ASW tactics and weapons has been apparent. The Soviets have given publicity to the helicopter as an ASW device. One innovation consists of a small Hen (KA-15) operated from a special platform on the fantail of a Kotlin-class destroyer. Statements in the press indicate it is used for hunting and destroying submarines.

A recent article in the Russian magazine Soviet Fleet states: "Helicopters have for sometime been used . . . to deliver mail, accomplish communications, and (perform) reconnaissance between ships and shore. But today, the helicopter personnel of sub-unit 'N' have another task. They fly bombing missions. The pilots have been taught to adapt skillfully the low-speed machine for flights along difficult routes in search and pursuit of underwater (enemy) submarines. . . ."

Concern with this phase of naval warfare can be expected to increase rapidly as the threat becomes more serious to Russian security. Future Soviet ASW capabilities will be enhanced by introduction of specialized aircraft and equipment similiar to our own Navy's P3V Trident. Helicopters, both manned and remote controlled, can be expected in increased numbers.

What does all this mean? Is the threat of Russia's naval aviation real? Can a land-based naval air-arm do an effective job?

The Soviets have bases on their homeland and in satellite countries that put the English Channel, the North Sea, and every port in Northwestern Europe within the reach of light bombers. Medium bombers



ANTI-SHIPPING BOMBER (TU-16 Badger) extends Soviet menace over entire Mediterranean, Persian Gulf, Indian Ocean, North Sea and Atlantic Ocean toward Iceland.

could range far out over the North Sea and Atlantic Ocean toward Iceland.

In the Mediterranean area, flying from Southern Bulgaria the Bosun (TU-14) and Beagle (IL-28) could cover the eastern end of the sea, and many Italian ports. The longer range Badger could be used to lay mines in any part of the Persian Gulf and even the Indian Ocean.

The situation in the Pacific is obvious. Approaches to the South China Sea, East China Sea, Japanese Islands and the Bering Sea are within range. Every port in Japan can be reached by Russia's naval aircraft.

Soviet navy is also known to have considerable interest in the Arctic approaches to their country. They have been pictured operating aircraft from rolled-snow runways.

The air power of the Soviet navy is not nearly so great as our own. But US shipping has never faced such a modern, long-range striking force.

Based on an article by Cdr. Edward L. Barker in United States Naval Institute Proceedings, January 1961.

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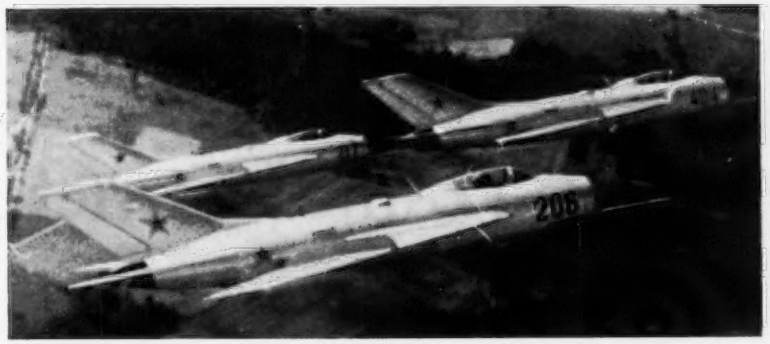

SUPERSONIC FARMERS (MIG-19's) have been reported as operational in Soviet Naval units, armed with target-seeking air-to-air missiles. Performance is estimated at Mach 1.4, with a ceiling of 58,000 ft. Farmers would probably operate within 200 to 300 miles of coastal bases since max range is estimated at 800 mi.

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FRESCOS AT SEA with wing full-tanks can menace shipping to 500 mi. Aircraft carries air-to-air rockets and bombs at near sonic speed.

TWIN JET BEAGLE was introduced into Soviet naval aviation in early 50's. It has a mine/torpedo mission. Naval personnel are shown doing repairs to engine.

"Chain-Frame" Structures

Bamboo inspires new concept in filament wound structures; Prototype pieces lighter, stronger than equivalent magnesium parts

Bamboo has inspired a revolutionary structural concept that could have a great impact on the aerospace industries. Using filament winding techniques, the structural pattern of bamboo has been copied and improved on to produce units both stronger and lighter than equivalent magnesium parts.

Proman Inc., in studying bamboo reasoned that its strength was due in major part to unidirectional silica loaded fibers just under a tough peripherial shell. The modules which "block off" sections of the stalk were found to be pulp-like in make-up. Though the nodes are the weakest part of the bamboo's "design" they provide the rigidity which prevents crushing and splitting in the fiber walls. But what if the node too had the strength of fiber construction? This would give much greater strength, more than nature ever intended bamboo should have.

Using 60-end, E-glass roving, saturated with polyester resin, Proman Inc. wound a structure which it calls a "chain frame." The name derives from the close resemblance of the structure to the links of a chain. The impregnated glass filaments are wound over a complex steel mold in such a pattern as to orient the fibers through the "node" as well as through the longitudinal chain direction. If a longitudinal slice through the center of a bamboo stalk is pictured (Fig. 1) it can be seen that the man-made structure has a strength advantage over its "ancestry" in nature.

The kind of mold used in preliminary chain-frame work is shown in Fig. 2. Note how fibers are laced in and out around the winding blocks as well as being stretched straight through. This creates problems in manufacture but results in a stronger structure.

Proman Inc. has found that filament tension is extremely important in this winding process. Not enough tension produces a weak structure. Too much tension causes filaments to bunch up on the winding block and results in resin starvation. Variations in physical properties of ± 30 per cent can be caused by inadequate tension control.

Prototype missile parts have been constructed by employing a modular design. First shape made (Fig. 3) was a 30 in. diam ring similar in dimensions to a Discoverer nose section. Modules consist of "box shapes" each representing 30 degrees of arc. Twelve modules are joined together with adhesive bonding and mechanical fasteners to make a complete ring.

This method of construction is not as troublesome as it might seem considering the comparative cost and time involved in forging and machining similar parts from metal.

Manufacturing and marketing of the chain frame has been turned over to B. F. Goodrich, Aviation Products Division.

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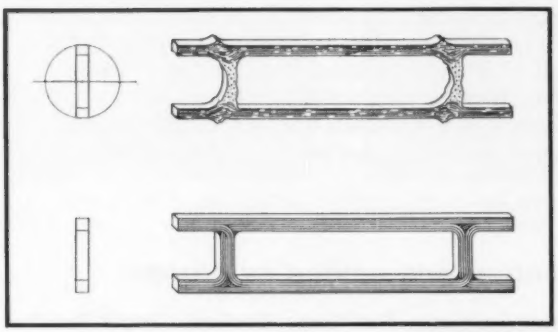
FIG. 1. FIBER ORIENTATION in natural bamboo is compared with design of man-made structure. View is center slice through longitudinal axis. Node in bamboo is pulp-like, and bamboo segment is fragile when removed from its stalk. But, learning from nature, Proman Inc. has improved this structure in its E-glass and polyester "chain frame."



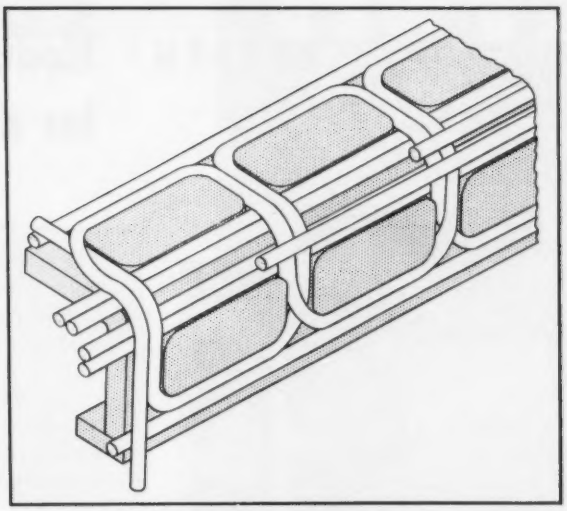


FIG. 2. CHAIN FRAME MOLD employs winding blocks to keep E-glass filaments oriented. All filaments are not wound in and out around blocks. Some stretch straight through. Stapling of filaments creates problems in manufacture but results in high strength structure.

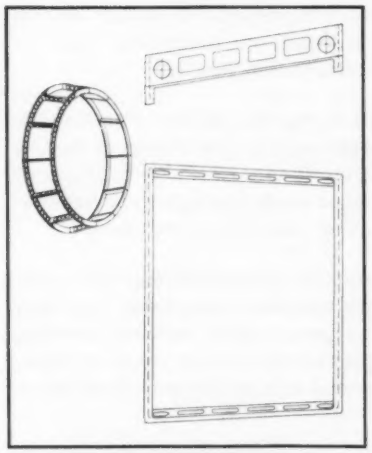
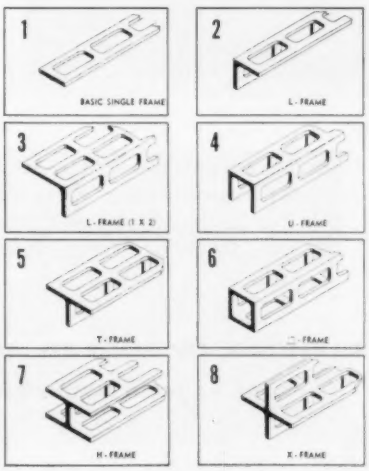


FIG. 3. MODULAR DESIGN was employed to make 30-in. diam Discoverer nose section (manufacturing prototype). Each module is a "box section" of 30 deg arc; 12 modules are joined with adhesive and mechanical fasteners to complete ring. Structures of this type are envisioned as flare skirts for joining stages, as the missile structure itself, and as tapered nose sections.

FIG. 4. FRAME DESIGNS that have been developed using the continuous filament offer a host of possibilities.



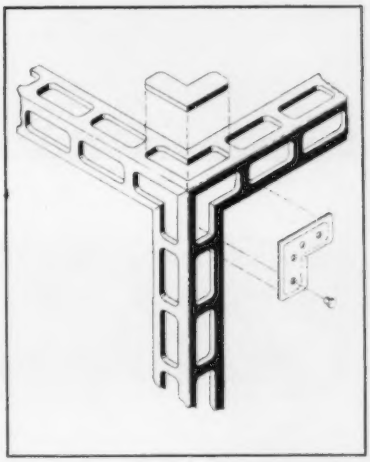


FIG. 5. CORNER "L" FRAME can be constructed from three single frames. Adhesive bonding, and mechanical fastening can be employed to join individual segments.

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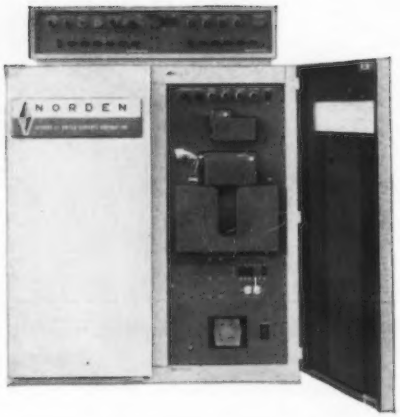
NORDEN

Modumatic control systems for automatic positioning



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AIRCRAFT & MISSILES
SPECIAL REPORT

ASW
THE CHALLENGE
AND THE PROGRESS

Editor Tom MacNew with Secretary of the Navy John B. Connally.

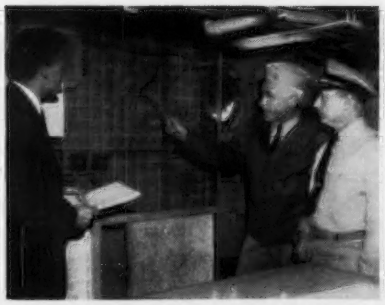
West Coast Editor Phil Geddes at commissioning of USS Teddy Roosevelt.

Where there are new military requirements, there are new requirements for industry. The two are accompanied by new markets. Anti-submarine Warfare (ASW) is such an area. About $1.5 billion is spent annually. Another $1.0 billion will be needed each year for the next few years to keep this force, which assures our freedom of the seas, equal to its task.

What is needed? More of what we have, plus new equipment to detect and pinpoint submarines, new planes and ships; and new communications equipment to coordinate tactics of air, surface, and underwater hunter-killer teams. Secret projects like Pangloss will give us some of the answers. But we need fresh ideas, streamlined management, and revolutionary approaches across the board.

ASW will spawn a whole family of new technologies. To bring you the ASW facts on "What We Have And What We Need" the editors interviewed experts in the Pentagon, in industry, and went to sea in the planes and ships of Task Group ALFA.

Managing Editor John Kushnerick with VADM Robert B. Pirie DCNO (Air).



News Editor Pete Sigmund on board USS Valley Forge at sea with Task Group ALFA.

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ASW...What We Have And What We Need

**Freedom of seas could be challenged by 450 hostile submarines,
Nuclear powered submarines can out-run present destroyers,
Better detection and localization are critical needs**

Staff Report

INTERVIEW WITH SECNAV

During a special interview of John B. Connally, Secretary of the Navy, by Tom Mac New, Editor, the following aspects of Anti-Submarine Warfare were discussed:

Question—What organizational changes do you plan for ASW in the immediate future?

Answer—At the present time, I contemplate no major changes in the Navy's organization. However, I wish to point out very emphatically that our present organization is not a static one. Within the past three years, there have been quite a number of organizational changes. Among the most important, I might mention the establishment of the ASN(R&D). Mr. Wakelin, under whom the entire ASW research and development program is strictly controlled through program approval and through management of the research, development test and evaluation program budget. Additionally, in research, the establishment of the Deputy Chief of Naval Operations (Development), Vice Admiral Hayward, was provided for stronger program coordination within the Office of the Chief of Naval Operations.

In the fleet there were set up new ASW commands in both the Atlantic and Pacific, under Vice Admirals Taylor and Thach. The new "Selected Reserve" is a significant addition to our potential ASW strength.

Within the Undersea Warfare Research and Development Planning Counsel we are organizing a Systems Analysis Group to provide us with a continuing review of development programs and recommendations.

Question—Do you plan a Czar for ASW R&D comparable to Admirals Raborn or Rickover?

Answer—The question of a Czar for ASW R&D or to use another term, single manager, must be considered within the context of the programs to which it relates.

In ASW R&D the Navy's programs are not oriented towards a single weapon or weapon system. Our programs involve rather the entire complement of our Naval forces.

The entire program is under the direct supervision of ASN(R&D) as we have previously stated. Our effort is reviewed at the highest level of the Navy in the Secretary of the Navy ASW Committee, of which I am Chairman. To answer your question specifically, I do not now plan a Czar for ASW R&D in the context of a single manager.

Question—What additional equipment do you desire?

Answer—This question is really too broad to answer. ASW influences the entire complex of Naval operations. It takes a numerous and diverse anti-submarine force to do the job. The individual units have to measure up to high standards of quality of course, but in addition they are noted in quantity. Every lesson showed that in ASW there is no substitute for numbers. As Admiral Burke and I have testified recently to the Congress, the Navy is spread too thin for the job the country is calling upon it to do, and this applies to ASW as well as to all the Navy's other jobs.

Question—How much additional money should you have?

Answer—There is much that could be done, productively and efficiently, with additional money in ASW—but I certainly could not recommend that the ASW share of the Navy budget be increased at the expense of any of the other sea-warfare capabilities.

"450 submarines are a great threat" "airpower is our basic means of attack" "we need electronic search devices" "we welcome unsolicited proposals" "ASW is cat and mouse tactics" "ASW czar? . . . Admiral Burke"

VADM. PIRIE COMMENTS ON ASW AND AIRCRAFT

Navy is spending about $1.5 billion annually on anti-submarine warfare (ASW). A report that went to Secretary of the Navy Connally shortly after he took office states it will take an additional $1-billion to make ASW forces equal to the task they face.

The task is measured in terms of enemy submarines. About 450 are known to be operational with Communist-bloc navies. At least 400 of these submarines are Soviet. Over 330,000,000 cubic miles of water are a potential hiding place for this anti-shipping, missile-launching menace.

On one hand the U. S. Navy's ASW force is many times over the greatest in the world. On the other hand it is inadequate. All of the Communist submarines now in operational status are conventionally powered. They must make a great deal of noise to run at speed while submerged. They must surface to recharge batteries. They cannot run at extreme depths. These factors make them detectable with sonars and radars.

Nature of the Challenge—Nuclear submarines are being developed in Russia. These can run fast (well over 40 knots), deep, and quiet. They can stay submerged for very long periods. We are not at the moment adequately equipped to fight such elusive craft.

There is time. How much is the question. Our own nuclear submarine became operational in less than five years after we set our minds to the task. The Russians have already set their minds to the task. They have the advantage of at least limited knowledge of our own findings.

What could an aggressor do with a large submarine force? Launch missiles like Polaris, and threaten free access to seas for shipping. The latter is the more likely menace. Since concealment is the prime advantage of missile-launching submarines, the Soviets need not direct great amounts of time and great sums of money on Polaris-type submarines. They have already achieved concealment with their land bases and have the boost power to reach any target on Earth from any direction.

An Admiral in our Polaris program says of Russia's concealment: "There is not one man in government who can pinpoint four Soviet ballistic missile bases. There are a few who can tell you where there are two, but not the hardware that is on them.

"We're not even sure we know the exact longitude and latitude of Moscow. We know the position of our Polaris submarines much more accurately than we know the positions of their targets."

The Broad Problems — What problems must Navy solve to even the odds with the submarine? How can it keep the seas safe and free?

It must find adequate means to detect, isolate, identify and kill. The kill is the least of the problems. Homing weapons and nuclear ordnance now operational are extremely effective. But you can't "kill" until you "find." And the ocean environment presents some formidable barriers.

Fnding the submarine encompasses search, detection, isolation, and identification. Radar is used for surface search. New radars are extremely efficient. But submarines are not prone to expose themselves to radar by running on the surface. This would put the advantage with the ASW force. It must be assumed the submarine will operate in the environment which gives him the advantage—submerged.

For underwater detection, we currently rely on sonar (Sound Navigation And Ranging) devices. These devices all listen for submarine noises in the deep ocean. But the sea is full of other noises that confuse sonar.

The Role Of Sonar — Some sonars merely listen (they are called "passive"). Others generate their own high frequency sound, then beam it out and listen for an echo (they are called "active").

Airpower seen as basic means of attack in ASW; S2F-3, P2V, and P3V equipped with Julie-Jezebel

Schools of fish, whales, and uncharted "mountains" on the ocean floor can give false echoes. Snapping shrimp, booming drumfish, and squealing porpoises can "cry wolf" on a sonar, or block a real signal.

The first hundred feet or so of water below the surface is temperature-stratified. A phenomenon called the "thermal layer" can bounce back a sonar wave as effectively as a tin roof. This means submarines can hide in or under this layer.

Ranging is not very accurate at great distances with sonar. The water temperature, pressure and salinity between the hunter and the prey are seldom known with precision. The speed with which sound travels through this medium is therefore not known with precision. So sonar-ranging is educated guessing. Undeniably limited, sonar is the only search device that is effective at all.

The more accurate, longer-range sonars are the "variable depth" types. They go down deep in submarines, or are suspended from ships and helicopters by cable. These sonars get beneath the thermal layer.

Aircraft In ASW—The marriage of sonar to aircraft has been a boon to ASW. The aircraft can move fast and cover large areas. Ever-increasing speed of submarines render the once-effective destroyer inadequate to the task of attack. Conventionally-powered destroyers are hard-put to keep up with nuclear subs. And when conventional surface craft run at full speed, they generate so much noise that efficiency of onboard sonar is greatly diminished.

It is no secret that our destroyer forces are tired. Average age of destroyers now in service is 14 years. Normal life is 15 years. Modernization and rehabilitation will extend life. But this is an emergency measure, not a desired course of action. Missiles (like Asroc) and remote-controlled helicopters (DASH) make up for some of the destroyer's deficiencies.

Aircraft and missiles are assuming a new importance in ASW. VADM Robert B. Pirie, DCNO (Air) states that airpower is "the basic means of attack," in ASW.

"All aircraft carry a family of weapons and detection devices," the Admiral says. "The new Julie-Jezebel system with its airborne digital computer and simplified information display is one of the best pieces of gear we have. It can be used for search or localizing. We also have the MAD (Magnetic Airborne Detection) gear, and exhaust detectors that allow us to home on combustion products of a snorkeling sub. And of course we have radar for surface search."

What can Adm. Pirie do with his planes, carriers, and helicopters? He could "set up an airborne extension of DEW Line that would make it near impossible for an enemy submarine to run on the surface within 1000 miles of any U. S. or Canadian industrial site." Since current Soviet missile launching submarines must surface to dispatch their weapons, their effectiveness would at least be challenged. Next, Adm. Pirie wants "an electronic detection device that will allow airborne detection of submerged vessels at 25 miles."

Non-acoustics—The non-acoustical search device which the admiral mentioned heads the list of things the Navy needs badly. Infrared is being explored, as are "pure electronic" devices. The "localization" of a "detection" currently hinges in the MAD gear in many cases. But MAD requires that an aircraft run almost exactly over the submarine's position. MAD is also confused by the magnetic emission of the aircraft itself. There is some consideration being given to reverting to a wire-trailing antenna. (MAD now uses a retractable tail boom on S2F-3 and a fixed boom on P2V and P3V.) Another shortcoming of MAD is that it can be neutralized. As merchant vessels were demagnetized to beat magnetic mines, nuclear subs have enough power on board to demagnetize themselves against MAD.

"MAD-Buoys" are being investigated for use in conjunction with sonobuoys. Initial contact would be made by the sound device, MAD-Buoy would tell if contact were a whale, school of fish, or magnetic object.

Product Improvement—Before Navy turns to entirely new devices, it aims to product-improve the old. But the budget is tight. And Navy is not buying marginal improvement. Increase in capability is always equated with cost. If a 10 per cent increase in performance means a 10 per cent increase in cost, Navy will probably not buy the new gear. "Don't sacrifice numbers" is the key in deciding to buy new gear or re-order old.

Communications — No single weapon or system can be effective against the submarine. Aircraft, ships and anti-submarine submarines (killer subs) operate as a team. As desirable as it would be, there is no way for a fixed wing aircraft to communicate directly with an underway, submerged submarine. Some available communication methods are: (1) Through sonobuoys dropped in the water. Submarine sends signal through water to sonobuoy which then sends signal through air to aircraft. (2) Through cables. Helicopters can dip sonar devices that allow two-way communications. (3) Floating antennas. Submarines lying beneath the thermal layer can reel out an antenna float that allows voice communications with aircraft. Underwater communications is in its infancy.

Some R&D Problems — About $30-million a year is spent on research and development in under-

water acoustics. This is a small sum when measured against the enormity of the problems to be solved. A scientist at the Naval Electronic Laboratories recently said, "There is a lot of talk but little money going into R&D—the money is going into hardware to kill submarines, not to detect them." Powerful underwater acoustics in reality represents probably the only foreseeable hope in long-range detection.

There are several problems involved in generating high acoustic power, the most basic being cavitation and the strength of materials. Cavitation at the face of the projector causes signal distortion. The point can be reached where increased driving power results in less acoustic output due to cavitation voids. When frequencies below 8kc are used, crystal, have to be so large that they break when a signal is applied to them. In designs for low frequency operation, magnetic elements can get so big and heavy that they are impractical. Electrostrictive ceramics can be used. They provide reasonable size elements and can be mass loaded to reduce the resonant frequency. Bandwidths of at least half an octave are desirable for some signal-processing methods. This in turn places a restraint upon the designer. Above the 8kc frequency range, available projector element materials have proved satisfactory.

Crystals could be of quartz, Rochelle salt, or ammonium dihydrogen phosphate. Magnetostrictive elements could be: laminated stacks, tubes, rods and even various ceramics such as barium titanate and PZT mixtures.* Transducer elements at the higher than 8kc frequencies have been pushed to the limits of physical development.

Work in the low frequency range has included use of mass-loaded barium titanate, large ceramic cylinders, mechanical devices, loud speaker-type elements and even shaped - explosive charges. Coupling to the water has only worked with some of these elements. To quote Dr. Donald Wilson of N.E.L., "We need badly a highly efficient, broad band, light weight projector element with a coupling efficiency of more than 0.6."

Lead, Zirconate, Titanate

Cavitations and High Power—The cavitation value near the surface of the ocean is about 2 watts per sq. cm; the cavitation threshold increases with depth. However, in practice, the limit appears to be not the operating depth but the strength of the materials used in the transducer. There is need for cements, active elements, and loading materials, stronger mechanically than those currently available. Secondly, there is need for a smooth, acoustically - transparent surface coating for the face of the active element, with low interfacial tension with sea water.

The theory of obtaining the best signal-to-background ratio with accurate bearing information is well known. This is achieved practically by forming many narrow preformed receiving beams from an array of elements. Need exists for several components for signal delay. N.E.L. researchers indicated that small inexpensive delay line components (solid state) are not available. Also, if hydrophone elements with digital outputs were developed, this would allow signal processing by computer.

Signal Interpretation—The end purpose of all the mechanical and electronic devices used in underwater detection is to enable "people" to interpret sets of signals. Automated detection, fire, and kill are a long way off. In the field of presentation, the problem is complex. For example, in covering 360 deg with two deg beams in the azimuth and ten layers of these beams, you arrive at 1800 deg preformed beams from which a signal could originate. To avoid dead time, there are several output signal transmissions. With these beam signal returns, there must also be doppler information displayed to the operator. Conventional PPI displays, B-scan, expanded sweep etc., are said to be "entirely inadequate." The information display problem is so complex that only a three dimensional status display, used in conjunction with auxiliary displays for such things as range rate and classification, can provide the necessary readable outputs. There is no evidence that the display problem has been solved, although it is undoubtedly receiving attention.

Sonar at Depth—In sonars operating at great depths, there are certain problems inherent in the equipment other than keeping transducers water tight and providing power supplies. Loss of polarization or shift in the Curie point at high pressures cause loss of efficiency in some transducer materials. Pressure compensation is a great problem still demanding attention.

Ordinary pressure release and reflecting materials become acoustically stiff and useless, when subject to high pressures. Much remains to be done in providing good pressure release materials, according to Dr. Wilson. He adds that there are ways of meeting the problem with cistatic structures but these are not always desirable. The discovery of a fluid which would be considerably more compliant than water would be a tremendous help.

Thermal shock at great depths is also a problem. Because the coefficient of expansion of active transducer elements is considerably different from the material used for supporting structures and mass loading, breakage often results.

Present dipping sonar used by helicopters has a tendency to trail along near the ocean surface as the copter flies forward. The Navy needs a strong flexible cable which would enable the sonar gear to go down deep, and stay down.

A real advance could be made if we had a material with the strength of metal, yet acoustically transparent.

✦

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ADMIRALS AGREE . . . NO ASW CZAR NEEDED

ADM. ARLEIGH BURKE
"an impossible task for any one nation"

RADM. LLOYD MUSTIN
"dancing in the corridors of the Kremlin"

RADM. JOHN E. CLARK
"confusion and cross purpose the only result"

Navy Streamlines ASW Management

Pressure of underwater challenge catalyzes reorganization; NSIA provides vital link in military-industry technical liaison; Admirals veto position of anti-submarine czar

by John P. Kushnerick

Admirals don't always agree. But on managing the Navy's ASW program they walk the same fine line, matching footprint for footprint. There is unanimous opposition to a single manager for ASW.

Navy has spent the past year or so putting its ASW house in order. The job is not finished. There are still a few small housekeeping chores to be done. But it is not going to require a "czar" to see these tasks through, the admirals feel.

Unsolicited Advice—A great deal of unsolicited advice has been offered Navy to "modernize" its ASW management. The most common suggestion is to put ASW in a kind of Special Projects office. Handle it like the Manhattan Project, or Admiral Rickover's nuclear propulsion program, or like the Polaris program.

Rear Admiral L. M. Mustin, who as Admiral Burke's Special Assistant for ASW is as close to an "ASW czar" as Navy has ever come, says of the single-manager concept: "If we ever did such a thing there would be dancing in the corridors of the Kremlin."

Vice Admiral Robert B. Pirie, who as DCNO for Air runs the aerospace portion of the ASW program, says facetiously: "We've got an ASW czar, Admiral Burke."

Rear Admiral John E. Clark, Commander of Atlantic Hunter-Killer Forces, is with the operational forces. He views an ASW czar this way: "Confusion and cross purposes would be the only result of setting up a special department for each important facet of Naval warfare. Homogeneity is more important than specialization. The present management setup is working satisfactorily."

Admiral Burke made his own feelings clear when he said: "The sheer magnitude of the seas makes anti-submarine warfare a nearly impossible task for any one nation all by itself."

What's wrong with the "czar" concept? Several things, as Adm. Mustin sees it:

(1) ASW is too big for a single manager to handle. It embraces 46

per cent of all the personnel Navy has afloat.

(2) Special projects rob top talent and top dollars from other areas. You can have just so many "special projects" then you start running out of men and money.

(3) All of the so called czars of the recent past, Gen. Groves, Adm. Rickover, and Adm. Raborn started with nothing and set out to produce a special piece of hardware. Our present ASW equipment is not a "nothing" proposition; it *is* operating forces.

That's why Rear Admiral Mustin thinks it would be folly to put one man in complete command of this huge complex.

Actually the situation is further complicated by the fact that our operating forces are under the control of various unified and specified commands, and the NATO, SEATO commanders. What we think of as our own top naval executives, actually only equip and deploy the Navy to the operational commanders. Admiral Burke orders few, if any, units into direct action.

Organizing For ASW—Current Navy organization takes care of most of the ASW problems. Those matters still requiring attention are not being ignored. Budgetary limitations restrict activity. One such item is the establishment of an ASW Information Center.

Navy organization is bilineal. One segment handles military direction, the other handles business management. Respectively, these are CNO and UNSECNAV (Under Secretary of Navy).

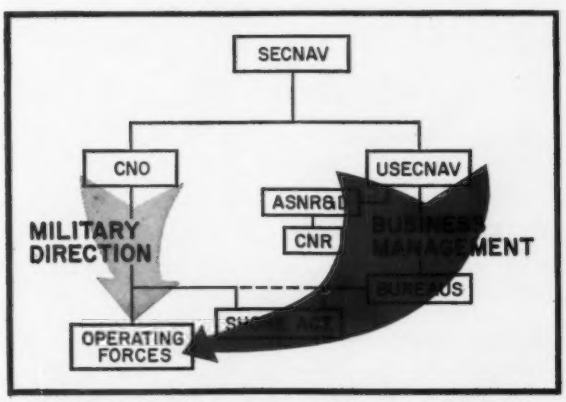
The Chief of Naval Operations is the military superior of all operating forces. He determines their needs with the aid of his staffs.

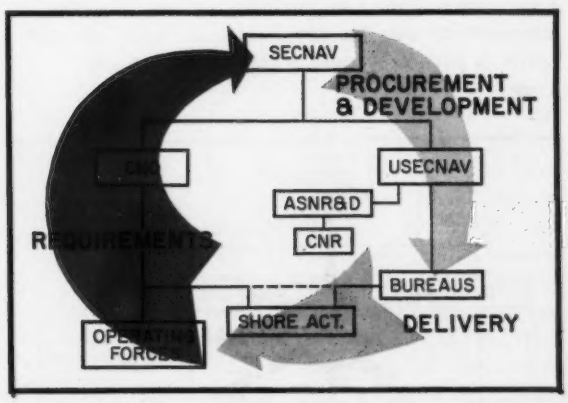
The business management line fills the needs prescribed by CNO. It is headed by the civilian secretariat. No other service has this kind of management. Navy of course feels that their method is a desirable manifestation of civilian control of the military.

The Buying Patterns—The Bureaus within the Navy then do the actual buying. This is where the contractors must do business. Many top officials in CNO's office, however, listen to proposals from industry because they must keep informed on expanding technology in industry. These same officials feel that many companies are, however, playing two ends against the middle. By selling ideas to CNO, they feel they are going to the top and CNO will set requirements oriented to their proposals for which Bu Ships or Bu Weps will then establish procurements. It won't work. As Capt. R. L. Dahllof states, "these people are only hurting themselves. They take up our time that should be directed to other things and they take up their own time that could be used better in selling the Bureaus, we don't sign any contracts." Capt. Dahallof also observes that some people are bound to get hurt in the ASW Business. With budgets being so tight, it is questionable whether there will be enough new procurement to keep alive all of the ASW Departments established in industrial firms over the past year or so.

Navy's approved budget, like all government appropriations, comes from Congress. The Congress maintains a Navy through appropriation of money. The budget, however, starts with the operating forces, as shown in the accompanying diagram. Each command advises the Secretary of the Navy what is needed to maintain a level of readiness the Secretary establishes. The Secretary reviews the request of those competing for funds, makes adjustments and submits the Navy budget to the Secretary of Defense who then fits this request into the total defense budget.

Eventually, Congress appropriates money through the "business management" channels, to the Bureaus and Offices. These spend the money. In many cases, however, a requirement established by CNO is tantamount to a contract for a specific company. This is because





BILINEAL MANAGEMENT has been established within Navy. Chief of Naval Operations sets military requirements, civilian secretariat handles business management. For ASW, this means CNO establishes what should be bought, USECNAV does the actual buying through the Bureaus. There is a constant flow of information on requirements and expenditures through the Secretary of the Navy's office as shown at right.

ASW spending is through bilineal structure, CNO sets needs, USECNAV is business manager

some weapon systems are so complex that there can be only one source. "Despite the nice sounding phrases about multiple sources, single source buying is something with which we must live," says one CNO spokesman. "Take the instance of a Heavy Attack jet aircraft. The Douglas A3D is obsolescent, and the Grumman A2F is not yet here. If CNO establishes an immediate need for 100 planes with an attack mission, BuWeps has only one route to follow, and it leads straight to the door of North American Aviation and the Vigilante."

In spending this money, the Bureaus remain flexible to the changing needs of the operating forces through CNO. Those in command and policy positions within the agencies that spend the money are professional naval officers. They attempt to equate their engineering knowledge with the spending function. The system is described as a "close-coupled and fast-reaction relationship between source and user to produce more combat capability per dollar."

Vital Link With Industry—The final link in an effective and powerful ASW organization is close coordination with industry. This is done primarily through the National Security Industrial Association (NSIA).

NSIA stays on top of the ASW situation. During the past year it completed an exhaustive study of ASW. Navy recognizes the qualifications of NSIA with respect to organization and business-like management as "unsurpassed."

In evaluating Navy's ASW management, its weapons and its problems, NSIA members travelled over one million miles, and put in more than 25 man-years of study. Their report included 86 areas of comment. Navy was already acting in 68 of these areas. The report was merely concurring that it was a good idea to explore these specific areas. The remaining 18 areas are all being acted on with one exception—a "single Manager System."

The NSIA Committee is pleased with the Navy's actions and will wait about a year before making further comment. Some of the changes Navy has made for managing ASW are listed in the following table.

MANAGEMENT CHANGES

How Navy Is Gearing to the ASW Challenge

1. Establishment in Nov. 1959 of the Secretary of the Navy's ASW Committee, a powerful directive body.
2. Establishment in Feb. 1959 of the Assistant Secretary of the Navy (R&D), with complete control of Navy R&D.
3. Establishment in January 1958 of the ASW Readiness Executive, a Flag Officer special assistant to CNO for all ASW matters.
4. Establishment in April 1959 of the Deputy Chief of Naval Operations (Development), with full control of R&D at the CNO level.
5. Consolidation of the Bureau of Aeronautics and the Bureau of Ordnance into the Bureau of Naval Weapons on 1 Dec. 1959 and,
6. Establishment of special ASW structures within the Bureau of Naval Weapons and the Bureau of Ships. ✦

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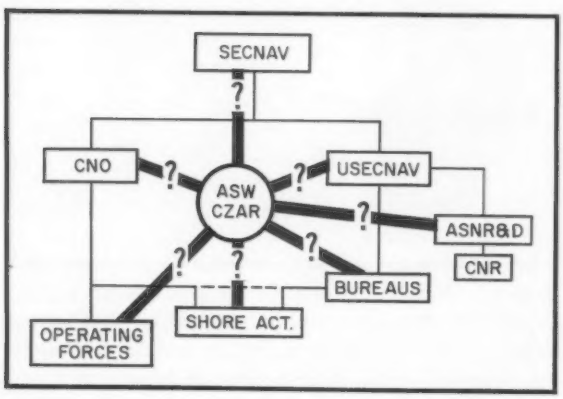
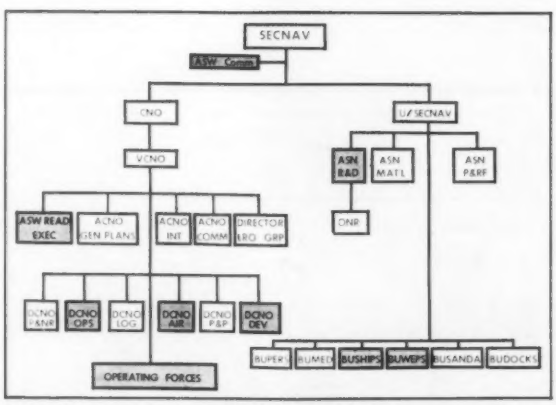
ASW CZAR doesn't fit into Navy's plans. No lines for responsibility can be envisioned by ASW planners. "ASW is part of everything Navy does."





OFFICES AND BUREAUS which have a special interest in ASW are shown in shaded blocks. Some recent management changes are: (1) An Assistant Secretary of the Navy (R&D), (2) An appropriate counterpart in CNO (Deputy Chief of Naval Operations Development). See table at end of article for complete list of management changes.

Exploring "Inner Space"

Neglected frontier may hold key to Nation's survival;
Broad oceanographic research promises commercial and military gains;
Navy's ten-year program outlines long-range activities

by S. Peter Kaprielyan

The ominous presence of nuclear power and rockets in the oceans has renewed men's latent interest in "inner space." This is the old, wet, vast and salty domain coving over 70 per cent of Earth's surface. There is now a growing awareness that this most abundant element has remained as the least explored. Hence, the likelihood of yet another "gap" looms over the horizon. Russia's stress in oceanography seems no less impressive than the size of her submarine fleet; and there is more than just a casual relationship in between.

Be it as a potential battlefield, or the vastest of the Earth's neglected resources, inner space will shape mankind's future as outer space is.

ICE EROSION TECHNIQUE is investigated at McMurdo Sound by Navy and Future Products Research, Inc. Method using forced water movement may serve to keep arctic ports and channels from ice-choking.

Importance of the Sea — The mechanics of the oceans dominates life throughout this planet by controlling weather and climate. Though still in a haphazard way, man derives an appreciable amount of his food from the sea, as well as metals, chemicals, fertilizers, and the unpolluted air he breathes. This wasteful custodian of Earth now dumps great amounts of carbon dioxide into the atmosphere; by photosynthesis the sea gives him back fresh oxygen. No one knows just how long this process can con-

Underwater cameras explore ocean floor without touching it;

Close off-bottom positioning averts stirring sediment and clouding field

tinue without affecting adversely this balance of nature. The same problem exists and will grow in magnitude with the mounting disposal of radioactive wastes. Hence, an intimate knowledge of deep-water behavior is urgently needed.

Consumption of water, in the U. S. alone, is estimated as 250,000 million gallons per day. The increasing need for fresh water for industrial and agricultural uses on a worldwide scale is also turning man's thoughts to the sea.

The prospect of extracting hydrogen from sea water, for fusion energy also offers the promise of unlimited power. Magnesium from sea water and dredged sea shells is now a reality; deep-sea dredging will undoubtedly lead to the mining of metals observed in nodules (clumps) on the ocean floor. Such nodules are rich in cobalt, nickel, manganese, and iron. Other metals present in sea water include gold, silver, lead, and zinc. Hydroelectric power from tidal motion remains as yet another unexplored possibility.

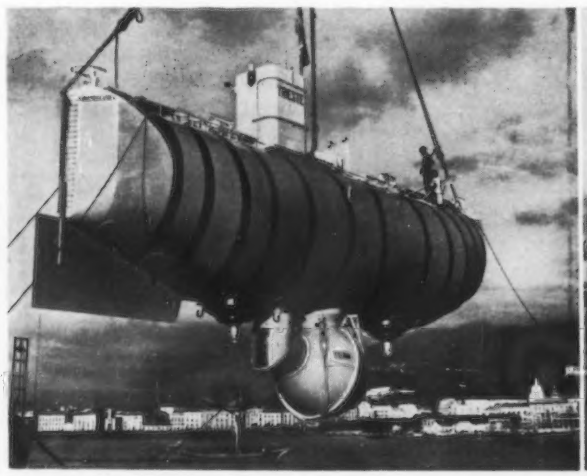
Lastly, in the event of a global conflict both for offensive and defensive purposes a thorough three-dimensional knowledge of the oceans may hold the key to survival for participants. Knowledge of this sort implies the exploration of over 300 million cubic miles of restless water in depth and in time. Of equal importance is an accurate survey of the ocean floor for navigation and possible concealment of submarines.

Tools for Oceanographic Research—In spite of the extreme accessibility of oceans, the basic tools for their exploration have remained mostly primitive. Needed are: detectors of sub-marine radioactivity, deep-sea seismographs, turbulence measuring instruments, etc. There is, however, equipment now in various stages of development, for a broad spectrum of oceanographic research.

On January 23, 1960, a Sputnik-caliber feat established a precedent in a reverse dimension. The bathyscaph, Trieste, manned by Dr. Jacques Piccard and Lt. Don Walsh, U. S. Navy, conquered the 35,800 ft Challenger Deep abyss of the Mariana Trench. The Trieste is operated by scientists of the Navy Electronics Lab., San Diego, under sponsorship of the Office of Naval Research and the Bureau of Ships. It was purchased by Navy from its designers and builders, Auguste and Jacques Piccard, Swiss physicists; it operates untethered under its own power when submerged, with a horizontal range of about a mile, and can survive pressures up to 8 tons/psi.

During the following months, the Trieste served a vital mission. Under project Nekton II, it was used for studies on sound propagation in deep water. The deep-diving techniques acquired through this bathyscaph will now contribute to the development of configurations for specific missions.

Another breed of research vessel is represented by the Aluminaut concept of Reynolds Metals Co. Made of 6-in. aluminum plate, the Aluminaut will have a 30-ft cylin-



BATHYSCAPH TRIESTE is comparable to an underwater balloon. Sausage-shaped float stores 33,350 gal aviation gasoline. Underslung sphere has 6-ft internal diam for a crew of two and equipment.

CONICAL-SHAPED WINDOWS (fore and aft) of Trieste gondola are of seven-in. plastic. Outside diam is about 16 in. but inside viewing area has only about 3.5-in. diam. Two-man crew shares 17 ft^3 of space.

drical pressure hull to carry about 3400 lb of instruments and a crew of two. With a cruising radius of nearly 100 mi, it would be able to dive to 15,000 ft—a depth corresponding probably to 60 per cent of the world's oceans.

Consultants on this project include: the Office of Naval Research, Southwest Research Institute, National Academy of Sciences, Woods Hole Oceanographic Institute, and Scripps Institution of Oceanography. Upon conclusion of negotiations with Navy, the $2-million Aluminaut will be built by the Electric Boat Div., General Dynamics Corp. and leased to the Navy Department.

A third approach to underwater research uses an unmanned Remote Underwater Manipulator (RUM) with television eyes. Purpose of the Navy RUM vehicle is to observe the sea floor, collect samples, and to install deep-sea instrumentation. Guided by sonar, the RUM is designed to crawl at 3 mi/hr down to 20,000 ft.

A reeled coaxial cable connects the vehicle to a van on shore. The RUM was developed under the direction of Dr. Victor Anderson of Scripps. When fully operational the RUM may incorporate a lift appendage, designed by Hughes Aircraft to allow underwater hovering.

Tanks, Cameras, and Porpoises—As in most scientific endeavors, a broad base of painstaking research is being used to probe the many unknowns of the underwater environment. Lockheed's Underwater Missile Facility, Sunnyvale, Calif., is a lab where thousands of repetitive underwater launch tests have been conducted before finalizing the design of the Polaris missile. Navy's Underwater Sound Reference Lab of the Office of Naval Research is located in Orlando, Fla. This facility boasts the most complete underwater sound measurement equipment in the world, including a 9500-gal tank for temperatures from near freezing to 100°F. The pressure in this tank may be controlled from a few psi to 1000 psi.

Photographic exploration of the ocean floor has recently furnished another means of probing the secrets of inner space. Coupled with sonar, special cameras have been successfully operated at 24,000 ft without touching the ocean floor. Developer of this equipment is Dr. Harold E. Edgerton of MIT and Edgerton, Germeshausen & Grier, Inc., Boston.

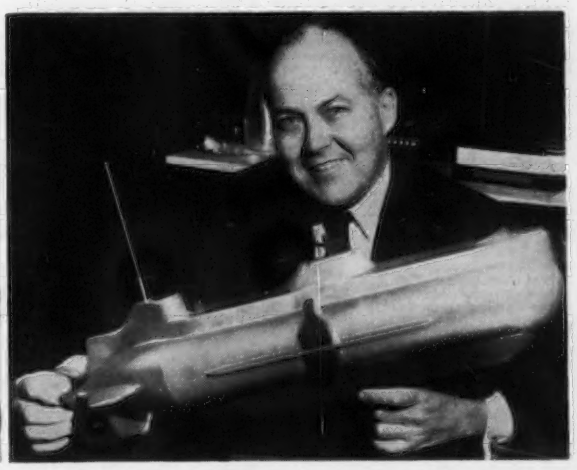
The antics of a three-year-old porpoise are also currently being studied by Naval Ordnance Test Station, China Lake, Calif., for serious purposes. Navy wants to know how this animal can swim at great speeds with so little drag, transmit and receive sounds across several miles, and withstand the pressures of the deep.

Early in January, this year, two hardy divers spent about half hour under eight feet of ice in Antarctica. The purpose of this numbing plunge in 28 F water by J. Thorne and D. H. Johnson was to observe the testing of an ice melting device developed by Future Products Research, Inc. The system, operating from below the ice cleared a 26 x 80-ft area in a week.

Surface Vessels—Due to tight budgetary considerations, most of the surface vessels used for oceanographic studies have thus far been hand-me-downs—converted salvage ships, old yachts, etc. The new look in research vessels of this class will soon be embodied by a $3-million vessel designed from hull up for oceanographic research. This 1040-ton, 175-ft ship will have an operating range of 7500 mi and a cruising speed of 12 kts. It will incorporate an integrated portable lab to simplify and speed up transfer of scientific equipment between ship and shore, and many features not possible in converted vessels.

For directly anti-submarine warfare (ASW) oriented studies the

TWO-PRONGED HAND OF RUM, developed by General Mills, Inc., simulates motions of human hand. Circles indicate arm actuators, "muscles," built by Ex-Cell-O Corp. Hull and track are from Ontos tank.



ALUMINAUT MODEL is displayed by J. Louis Reynolds, executive vice president, Reynolds Metals Co. The vertical propeller will allow underwater hovering, and control the rate of descent and ascent.

Non-uniform temperature structure of sea most dominant hindrance to sonar accuracy

Navy will use Auxiliary General Oceanographic Research (AGOR) ships. A $4.5-million contract was recently awarded to Christy Corp. Sturgeon Bay, Wis. for two AGOR's. These 1370-ton displacement vessels, capable of very quiet operations, will be used for sound-propagation studies. It is of interest to note that the largest Russian oceanographic research vessel reportedly displaces 6000 tons. Also, as recently reported by Adm. Burke, Chief of Naval Operations, before the House Armed Services Committee "The oceanographic exploratory fleet of the Soviet Academy is the world's largest. It has about 85 ships engaged in this effort. In comparison, the U. S. has 50 such ships including both naval and private types." The grandiose scale of Russian efforts in oceanography was displayed to some extent during the International Geophysical Year.

In February 1959, the Committee on Oceanography of the National Academy of Sciences, National Research Council made a study of U. S. needs in this field and detailed recommendations. The result was a broad program to expand U. S. capability for research at sea. This frontal attack on inner space became known as TENOC (TEN years of concentrated OCeanographic research) planned by the Office of Naval Research. The wide scope of TENOC may be appraised through the recommended expenditures. (See table.)

1960-1970

PURPOSE	$(1000)
Oceanographic Faculty Boosts	500/yr
85 Ships (500 to 2200 tons)	213,000
Shore Facilities	1,500
Shore Facility Operations	1,200/yr
Survey Ships (initial)	750
Operations per Ship	750/yr
Devices, Techniques, Aircraft	100,400
To Monitor Radioactivity	44,130
Marine Biology & Minerology	78,540

For International Cooperation in Oceanographic studies

(1960-1970)

BUDGET	$(1000)
Navy	278,240
Coast & Geodetic Survey	78,040
Bureau of Commercial Fisheries	123,160
Maritime Administration	10,900
National Science Foundation	121,040
Office of Education	5,000
Atomic Energy Commission	32,430
Bureau of Mines	2,600
Total	651,410

The Not So-Silent World—The din of the howling winds that often churn the visible surface of the ocean has its less conspicuous counterpart below. This noisy environment where the submarine operates offers much to confuse sonar—chief method of getting information through water over reasonable distances.

There are several ways of sending and receiving information through the air: light, sound, radio waves and infra-red. In water, the choice thus far narrows down to sound. This is because most known forms of energy radiation are absorbed within a few hundred feet. Hence, a considerable array of oceanographic instruments utilizes sound. Most common of these is the echo sounder which measures water depth under a ship by bouncing a controlled "ping" off the ocean floor.

Man - made noise, however, drowns easily among the vagaries of the undersea environment and the varieties of clatter produced by sea life. This "background" or noise originates from many sources: from the movement of water, ships, and propellers; by rain beating on the surface of the sea; and by the submarine itself bearing the sonar detectors.

Sound travels at 1100 ft/sec in air, 16,000 ft/sec through steel, and 4800 ft/sec in sea water. The speed of 4800 ft/sec, however, holds true only at surface pressure, a water temperature of 39 F, and salinity of 35 parts per thousand. Thus, sound velocity varies depending on temperature, salinity, and pressure.

- As temperature rises: elasticity increases greatly and density decreases.
- As salinity increases: elasticity increases greatly and density increases slightly.
- As pressure increases with depth: elasticity increases greatly and density increases slightly.

Since submarine operation is still confined to the upper ocean layers, the effect of temperature variations far outweigh the effects of either salinity or pressure.

Problems of Temperature Gradients—The effects of ocean currents, winds, tides and of the sun do much to make the lot of a sonar operator not an easy one. This is because the non-uniform warming of the sea results in stratification of layers which in turn refract the sound waves. In other words, the velocity of sound changes during its travel from its source to the detector. When this occurs, the following questions spring up. Did the sound follow a fairly straight course? Was it refracted by a cold or warm temperature layer? If it were refracted, how much did it bend, and in what direction?

Such questions are answered best by studying the temperature structure of the water in the immediate sonar operating area.

There are other things that happen to sound in the water: it is reflected from ship hulls, rocks, fish, kelp beds, air bubbles, even plant and animal organisms abounding in oceans; it spreads over larger and larger areas as it moves away from its source, and loses its intensity; sound is also attenuated—absorbed and/or scattered by the masses of minute particles of foreign matter in the water. Lastly, the doppler effect is also considered in piecing together effectively a sound picture of a sub's immediate environment.

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Aircraft, Missiles For ASW

COMPANY	SYSTEM	MISSION—TYPE	REMARKS
		—AIRCRAFT—	
Douglas	AD-5W Skyraider	Communications link and relay	Primary mission is early warning. Being replaced by Grumman W2F-1.
Goodyear	ZPG-3W (Blimp)	Communications link and relay	Displacement of 1.5 million cubic ft. Special ASW version proposed.
Grumman	S2F-1, -3 Tracker	Search and attack; carrier-based	Carries complete family of detection and kill gear. Dash has 2.3 hr. longer mission time, 18-in. longer fuselage.
Grumman	W2F-1 Hawkeye	Communications and relay	Primary mission is early warning. Is airborne data process center (ATDS).
Grumman	SA-16-B Alabatross		Being converted to carry sonobuoys, ECM, MAD, and radar, $1.65 million program.
Gyrodyne	DSN-1, -3 DASH	Drone Anti-Submarine Helicopter (Remote Control)	DSN-1 contractor demos. completed. DSN-3 in development will be turbine powered, carry two MK-44 torpedoes.
Kaman	HU2K-1	Primary mission, utility helicopter	Being evaluated for limited ASW, no final decision reached.
Kaman	HTK	Remote control, ASW helicopter	Evaluated as part of DASH program. Carries two homing torpedoes.
Lockheed	P2V-7 Neptune	Search and attack, land based	Primary land based ASW aircraft. Carries full family of detection and kill gear. 20 squadrons in service. Production to '62.
Lockheed	P3V-1 Trident	Search and attack, land based.	Will slowly replace P2V and P5M. See page 47 for details.
Martin	P5M-2 Marlin	Search and attack, seaplane	Ten squadrons in service. Production has terminated.
Sikorsky	HSS-1	Search and attack, helicopter	All weather craft with dip-sonar. Carries torpedoes or Lulu depth bomb.
Sikorsky	HSS-2	Search and attack, helicopter	All weather twin-turbine replacement for HSS-1, boat hull. Operational late '61.
		ROCKETS—TORPEDOES	
Avco	Weapon Alfa	Surface-to-underwater	Rocket powered depth bomb fired from destroyers. Weighs 500 lb.
Goodyear	Subroc	Underwater-to-air-to-underwater	Fired from submarines. Not operational. Librascope guidance, Thiokol propulsion. Range estimated about 30 miles.
Minneapolis-Honeywell	Asroc	Surface-to-underwater	Solid-rocket boosted MK-44 torpedo. Equipped with nuclear warhead.
Navy (In house)	Lulu	Air-to-underwater	Nuclear depth bomb. Carried on HSS-1, -2, S2F, P2V, P5M, probably on P3V.
Navy (In house)	MK-37 torpedo	Underwater-to-underwater	Silent-running electric propulsion.
Navy (In house)	MK-44 torpedo	Surface-to-underwater	Radio homing.
Navy (In house)	Hedgehog	Surface-to-underwater	Depth bomb fired in salvo from destroyers.
Vitro Laboratories	Mark 39 torpedo	Underwater-to-underwater	Wire-guided. Homing signals sent on closed circuit to prevent jamming. Runs "silent"; probably electric powered.
Westinghouse	Astor	Underwater-to-underwater	Thin anti-submarine torpedo; nuclear tipped and electric powered. GE makes salt-water battery which is power source. Guided by transitorized Sperry Gyro Co. MK-18 angle solver.

DETENTION EQUIPMENT

ECM—Electronic Counter Measure equipment detects radio and other electronic emission from submerged vessels. This kind of device was the key to finding submarines in WWII.

HEAT SEEKERS—Called "Sniffer Gear" detect combustion products emitted by the submarine's power plant.

JULIE-JEZEBEL—Two sonar systems have been combined, and offer the greatest hope for airborne search and detection. Jezebel is a super-listening device that detects submarine generated noise. It is not believed to have ranging capability, since most listening sonars do not. The tie-in Julie system uses explosive echo ranging. A pattern of sono-buoys picks up sounds as they bounce back from under water objects. Information from Julie-Jezebel is digested in an airborne computer and displayed in simplified, correlated manner for easy interpretation.

MAD GEAR—Magnetic Airborne Detectors are used for localizing a "find." Resonant magnetometers are being investigated to increase potential of MAD gear.

RADAR—Surface search radars are being deemphasized, although they are carried on all ASW aircraft.

DIPPING SONAR—Is used by helicopters and airships. AQS-4 developed by Raytheon is latest device. Raytheon is a leader in sonar development, has huge ASW center at Portsmouth, R. I.

SEARCH LIGHTS—Strong Electric Co. makes the AN/-AVQ-2C wing-mounted lights now in service on S2F and P2V.

ASW Hardware Evaluated

by Peter Sigmund

Keeping the seas free hinges on our ability to fight the submarine. But the submarine is an elusive prey. Hunting and killing this undersea menace demands constant development of new hardware.

To examine ASW in retrospect and prospect A&M went to RADM. John E. Clark, Commander Atlantic Hunter-Killer Forces, including Task Group Alfa. The chart in the opposite columns tells what we have; it is based largely on the Clark interview. Following are comments on what we need.

Q. What improvements must be made in our ASW capability?

Adm. Clark: We need faster, deeper, and more reliable classification equipment. By faster I mean the ability to determine quickly the exact nature of an object or objects picked up on detection gear. . . . By deeper, I mean equipment that can penetrate or operate below thermal layers and also tell exactly how deep the submerged object is. MAD gear on our S2F's, for instance, can tell us if an object is metallic. But it cannot measure range. Sonar likewise needs increased depth as well as range. Our long-range torpedoes need accurate depth determination in order to hit the target.

Q. What new types of detection hardware do you foresee?

Adm. Clark: First of all, there is plenty of room for improvement in what we already have. But we do need more refined equipment. Highly sensitive listening devices . . . electromagnetics, magnetics, gas emissions, infrared, all these have possibilities. Industry must be able to build and devise systems with enough sensitivity to do the measuring job.

Q. Once you have located a sub, can you "kill" at any depth?
Adm. Clark: We are well-armed at the present. We can reach a sub at any depth. The problem is finding and classifying. . . . We cannot go around bombing every school of fish in the ocean.

Q. Do you consider the ASW situation to be critical?
Adm. Clark: If we can't lick the sub, we've had it. Our country is so awed by and preoccupied with the atom that it has developed blinders. All people can think of is nuclear war. They forget that a victorious enemy submarine fleet could cut off our vital sea links. It is essential that a high order of priority be given to an immediately ready capability in ASW. Yes, the situation is critical. Every destroyer needs to be modernized with improved sonar and Asroc. We need to push an extended range for MAD gear. We need all-weather helicopters with improved magnetometers. We need more money . . . among technical people, we need a sense of urgency. The Russians have this sense of urgency or they wouldn't be running around in oceanographic survey ships.

Q. Will hydrofoils aid the ASW effort?
Adm. Clark: They would unquestionably be a big help, particularly for coastal ASW operations. Hydrofoils could reach a sub more quickly than present destroyers . . . (but) at present I can see no place for the hydrofoil in a task group such as Alfa. The carrier aircraft is our answer for quick arrival at the scene of action.

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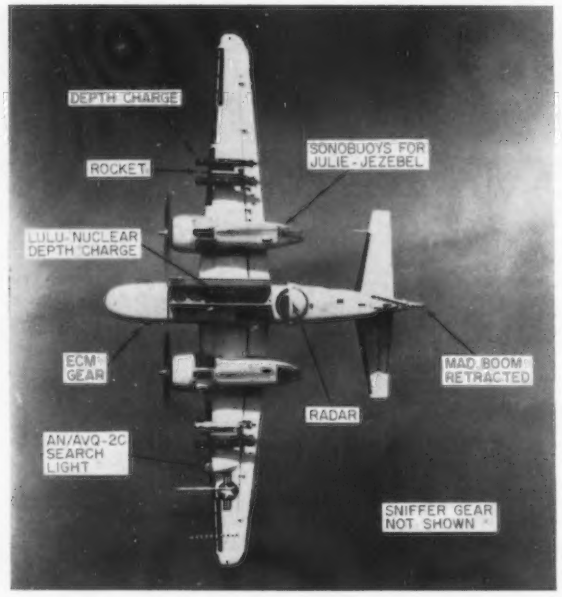
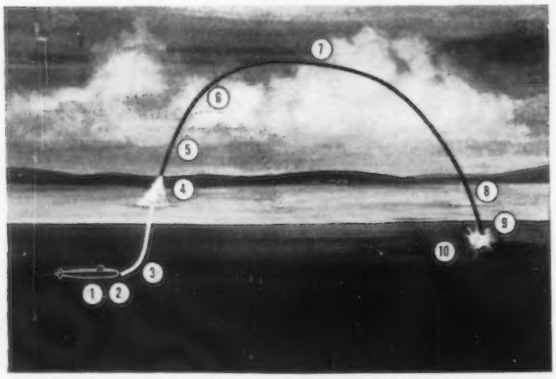


GRUMMANS' S2F-3 TRACKER carries same family of detection gear as larger P2V. Latest version of Tracker has 18-in. longer fuselage and 2-3 hr longer mission time than S2F-1. Tracker is main carrier-based ASW plane.

◀**DIPPING SONAR** and twin-turbine power plants are latest innovations for helicopter ASW. Sikorsky HSS-2 shown has all-weather capability. Boat hull is for emergency landing. Will be operational in late '61.

GYRODYNE "DASH" helicopter lands on special destroyer deck. Radar and sonar work together to put 'copter over sub location. DSN-3 model, entering fleet use this year, is reportedly capable of 100 knots. Turbine-powered, it carries two homing torpedoes.



SUBROC KILL SEQUENCE shows: (1) Target range and bearing obtained, guidance data stored in missile; (2) Launch; (3) Rocket-ignition safe distance from sub; (4) Thrust vector stabilization at water exit; (5) Azimuth determined; (6) Motor separation; (7) Inertial guidance for terminal trajectory; (8) Water impact; (9) Sink to calculated depth; (10) Kill.

Trident Sets Trend In ASW

Navy swings to land-based aircraft for coastal patrol and ASW, Lockheed's P3V and P2V edge seaplanes out of picture

by Philip Geddes

When Navy announced that seven-times modernized P2V Neptune had reached the end of its development cycle, the need for a new ASW aircraft was established. Lockheed was ready. It offered a military version of its turboprop Electra, now known as the P3V Trident. That was May 1958, and these were the salient sales points.

- Requires no long development program, since the Electra is in mass production and flying. This means early fleet availability.
- "Is a completely modern airplane, with a service potential of at least 15 years—and can be modified to design or equipment changes that may develop during that time.
- "Has a top speed exceeding 450 mph and can operate with economy and controllability low-to-the-water or high-in-the-sky.
- "Prop-jet power eliminates the need for extra-long runways.
- "Will incorporate Lockheed's 20 years of experience designing and building anti-submarine aircraft."

Before the first P3V could be delivered, and the prototype YP3V was still in early flight test, a series of Electra disasters occurred. There was speculation in aviation circles that the fate of the Trident hung in the balance with the Electra. The long detailed investigation began. Lockheed proved modifications could insure the structural integrity of the Electra.

Standing production orders of $124 million attest to Navy's concurence with Lockheed's report.

P3V Black Out—Adverse publicity surrounding the Electra, however, seems to have had an unfortunate reaction on Lockheed. The company has been unwilling to fully discuss certain Electra affairs. The modification program is one of these. This attitude has been carried over to the P3V in what now seems an attempt to disassociate the Navy aircraft from the Electra.

A statement regarding the similarity of basic airplane types and modifications to them is in keeping at this point.

"Because of the very nature of aircraft, once the basic specifications setting forth speed, range, payload, etc. of the airplane have been determined, the configuration is established, and little can be done to change these characteristics during the development stage."* With this idea in mind, and since details of the P3V are being withheld we will examine the Electra and comment on known facts about the P3V Trident.

Powerplants — Four Allison Model 501 D-13 engines delivering 3750 ESHP each at takeoff, are used on the Electra. These have been replaced with four Allison T56-A10-W engines driving 13.5 ft Hamilton Standard propellers to produce 4050 ESHP at takeoff. The T56 engine is directly related to the engines fitted to the Lockheed C-130B transport and enter service on the P3V with a reasonably long service history. Announced cruise speed for the P3V is "more than 400 mph" which compares directly with the cruise speed of the Electra. The Trident will be capable of coming down to low altitude and loafing along at "less than 200 mph using only two engines to extend time over target or areas of suspicion if desired." At combat weight the P3V can climb at 600 ft/min on two engines. Search range is said to be 40 percent more than front line ASW aircraft in current service. Unofficial Navy sources put patrol duration at 18 hr. Bulk of missions will be within 1500 mi of coast line.

Electronics—The Trident's ten-foot inside diameter fuselage will house two and a half tons of the most up-to-date electronic submarine detection gear available. This includes: Julie, active detection system; Jezebel, passive detection system; MAD, Magnetic Anomaly Detector; and Sniffer Gear. MAD, housed in the stinger tail, seeks out submerged metallic objects by noting deviation in the normal magnetic field. The Sniffer seeks out heat and combustion products exhausted into the atmosphere.

Position information is vital to an aircraft flying long hours over water. This is provided in the P3V by a Litton inertial system dampened in the Schuler mode by a continuous wave doppler radar. The doppler is not used as the primary navigator because of inaccuracies experienced in such systems when flying for a long time over water and in tight maneuvers. The navigation system provides three major outputs: (1) Direct reading position indication in degrees latitude and longitude accurate to one-tenth

**Application of Operations Research Techniques to Airborne Weapon System Planning by Robert A. Bailey, Lockheed Aircraft Corp.*

Turboprop Trident extends mission time to 18 hrs

minute of arc; (2) Distance travelled as a synchro output giving two nautical miles per revolution on a plotting board; (3) Various autopilot functions for stabilizing the plane's attitude and heading. The extremely accurate navigator ties in with the detection gear aboard by ensuring super position reporting to other fleet units and pin point reference on a plotting board phased in with the detection systems aboard. Thus when a string of sonar buoys or bombs are dropped there is no doubt about their position.

Dual radar antennas provide 360 deg coverage, eliminating propeller and wing reflections and shadows common to many airborne radars.

Structure—It can be assumed that the P3V structure is basically Electra, plus. Fuel content has been increased, it can also be assumed that some of the additional fuel is carried in the Electra sized wing, and possibly in a center section tank.

The fuselage is windowless except for two observation ports on both sides. The tail extension for the MAD gear plus the nose radar brings the P3V to 113 ft 7 in. compared with 104 ft 8 in. for the Electra.

The structural strength of the Electra was increased after one of the most extensive investigations ever to take place in the aviation industry. The cause of Electra structural failure lay in a whirl mode phenomena which originated in the propeller and induced a flutter in the wing eventually causing it to fail. The modifications (extracted from an F.A.A. report) for the failures were as follows:

(1) Additional mounts added to stabilize the propeller should any mount fail, or should breakage occur between the gearbox and the power section.

(2) Nacelle structure strengthened considerably by the addition of reinforcements and diagonal braces.

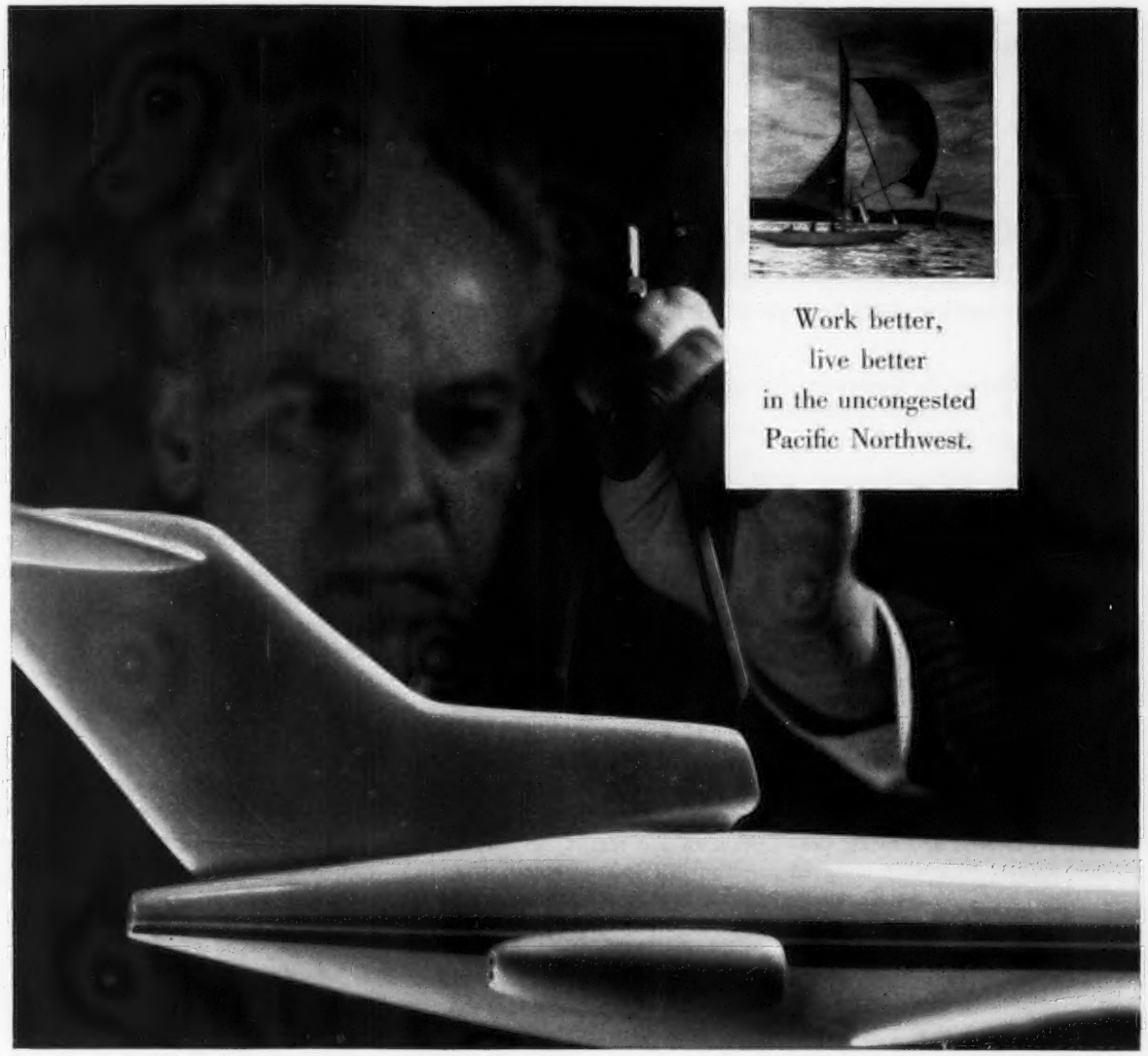
(3) Wing strength increased by: increasing thickness of three lower surface planks and one upper surface plank; reinforcing the front spar and wing lower surface; strengthening 18 ribs in each wing by additional diagonal braces and reinforcements.

After the modification, torture testing far beyond normal limits proved the Electra airframe. There is every reason to believe that the same fix and structural integrity will hold for Trident.

Trident will be capable of attacking with torpedoes, rockets, depth charges, and "specialized weapons" delivered separately or in a variety of armament mixes.

IS IT—OR ISN'T IT basically an Electra? Logic in buying P3V Trident for ASW was originally that it would be economical since it so closely paralleled Electra's design. There is now an over-obvious effort to disassociate the two aircraft. Trident is "completely redesigned" Navy claims. Y-Model is shown.

JULIE-JEZEBEL installation is one of latest modernization steps in P2V-7 Neptune. This aircraft is still mainstay of long-range ASW patrol. Production runs into 1962. Navy now has twenty P2V squadrons and 10 seaplane squadrons. Percentage of land-based squadrons will increase since all seaplane production has been terminated.



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UNDERWATER PROPULSION

Ramifications of the Rocket

Chemical rockets and ramjets researched for ASW; Could produce underwater speeds of 900 knots; Efficiency and range still less than conventional gear

by Calvin A. Gongwer, Manager
Anti-submarine Warfare Div.
Aerojet-General Corp.

Rockets and ramjets could provide the high-speed underwater propulsion systems for future anti-submarine warfare (ASW) weapons.

Liquid rocket propulsion systems, ramjet and turbojet underwater engines operate best in shallow depths. Depths for solid propellant rocket engines have no theoretical operating limits. Steady speeds for underwater jet engines will probably reach 300 kts. Several underwater jet and rocket propulsion systems have been designed and tested at Aerojet-General's ASW Div.

Underwater Ramjet — The underwater ramjet (Hydroduct) uses a heat source to flash sea water to steam at ram pressure. A highly concentrated non-gassing solid propellant serves as the heat source. It permits almost 100 per cent condensation of the steam formed from sea water. This important feature is necessary so that eventually the thermal cycles can be closed, thus making the engine depth-insensitive.

Like other ramjets, this engine must be boosted to running speed. After attaining running speed, sea water enters the nose diffuser, passes around the end burning solid propellant, and into the flames. Turbulators assure the uniform mixture of steam and combustion products. Steam generation is at nearly the ram pressure above ambient from which the expansion is rearward through a nozzle. Free-running ramjet devices attaining speeds in excess of 100 kts have been successfully tested by Aerojet on the underwater ranges of the Naval Ordnance Test Station.

However, present ramjet engines are sensitive to depth, since for a given speed the pressure ratio decreases as depth increases. Attempts to correct this with a jet condenser on the exhaust and other efforts have been unsuccessful.

Underwater Turbojet—A variation of the ramjet, an underwater turbojet (Hydroturbojet), has also been tested successfully. This unit uses a turbine-driven pump to force sea water into the combustion chamber. Combustion is between sea water and molten lithium, a water-reactive chemical. By using a pump in addition to ram pressure, the engine can accelerate from a standing start and operate satisfactorily at relatively low speeds.

Analogues for nearly every type of aerial jet engine have been studied and development has followed where it appeared feasible. However, development of practical underwater jet engines has been difficult for several reasons. First, although water is an oxidizer for certain water-reactive chemicals, these fuels are difficult to handle and therefore are logistically objectionable. Second, as water is incompressible, it cannot be used in an engine cycle unless it is flashed to steam. This requires large quantities of heat energy. Third, the ambient pressure increases so rapidly with depth that it is difficult to keep favorable pressure ratios in the cycle without going to prohibitively high pressures before expansion. This condition can be overcome with a steam condensing cycle where pressure and temperature of the liquid and vapor phases exist in near equilibrium.

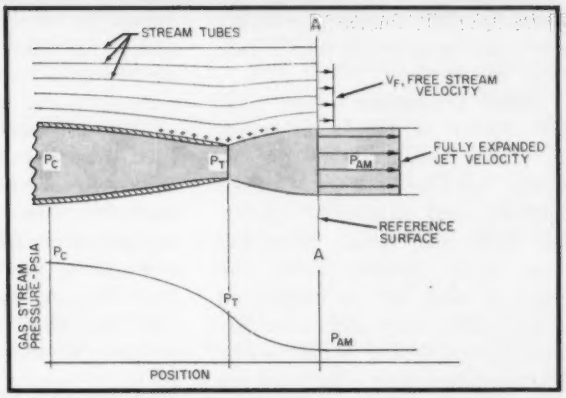
Although sea water hinders some phases of jet and rocket engine operations, it also has many advantages. Unlike the atmosphere, sea water is a high-density liquid. Therefore it requires much less energy to raise its pressure by pumps of the ram effect.

Early Efforts, Problems — The pulsejet (Hydropulse) was one of the early efforts in underwater jet propulsion. In its most successful configuration, the pulsejet is a straight pipe barrel enlarged slightly at the forward end to incorporate a reed-type inlet check valve. Located in front of the valve is a diffuser.

In operation, a liquid alkali metal fuel or other water reactive chemical is injected intermittently through a fine spray nozzle into the sea water-filled duct downstream of the valves. This injection is accompanied by a quick reaction at high pressure and temperature resulting in the generation of hydrogen gas and steam. The expanding gas exerts pressure, pushing rearward the barrelful of water as a piston. When the water has been expelled, the gas may be over-expanded, as in the

UNDERWATER EXHAUST pattern shows external expansion during test of a critical-pressure nozzle at Aerojet. Firm is immersed in underwater propulsion studies using rocket techniques.

UNDERWATER ROCKET studies show that typical external flow from a critical pressure nozzle follows the pattern diagramed at right. ▶



case of static operation and the pressure is below ambient. This causes new water to be drawn into the forward end through the valves and the cycle repeats. At high forward speeds, over-expansion is not necessary as ram pressure fills the barrel. Thus, there is no limit on the amount of gas generated during each cycle. An engine four and one half feet long with a four inch inside diam refilled and fired at 15 cycles /sec at a forward speed of 64 kts. It produced about 1000 lb thrust. Experimental engines using molten lithium fuel operated at about 60 per cent efficiency, which is better than many other systems.

Although this system ran powerfully and efficiently, it did have certain inherent drawbacks at high speeds. The intermittent intake of sea water through the diffuser affected the water flow around the exterior shell and external cavitation resulted at speeds above 60 kts in shallow depths. Multi-barrels from the same diffuser helped some but not enough. Even at high speeds the time to refill the chamber was too long—75 per cent of the cycle. To keep average thrust high, the reaction pressures in the duct had to be made high and rise steeply on fuel injection. This necessitated the use of very heavy construction to hold the valves and cage together. The ducts also occupied too much room inside the vessel to be propelled. These factors, together with the lack of a good water-reactive fuel, discouraged further development of the underwater pulsejet engine.

Advantages of Rocket Power—The tremendous advancements made in rocket propulsion performance for space exploration has not been realized in underwater devices because forward speeds of underwater rockets are much lower, consequently their propulsive efficiency is usually less than 5 per cent. Nevertheless, rocket propulsion systems can be extremely useful underwater because:

- They require no atmospheric air.
- They have a very high thrust per unit frontal area.
- The performance does not decrease rapidly with depth for solid propellant rockets using high chamber pressures.

This last reason is why solids are presently superior to liquid rocket engines for deep diving systems. The rocket's high thrust per unit frontal area, which is determined by the diam of combustion chamber or casing and nozzle, makes it an excellent device for high underwater speeds above about 90 kts.

Although underwater - rocket speeds are necessarily lower than those above water, the high power and thrust available can be very effective. Because of the high drag, the coast distance of underwater rocket powered missiles is also limited. Consequently, rocket engines are used as sustainers and a high-acceleration boost phase is necessary for trajectory stablization.

The effect of depth introduces complexities, especially in regard to the nozzle-exit-to-throat-area ratio. If the area ratio is proper for shallow running, it will be too great for deep running and considerable drag increase and loss of thrust will occur at depths. However, tests have

Rocket devices eliminate bugaboo of propeller cavitation; Hydrofoil craft could use hydraulic jet propulsion

shown that an under-expanded nozzle will work as a correctly expanded one if the missile body is streamlined and if it is not cavitating seriously so that the flow follows the body contours. Properly designed, the performance of a rocket nozzle can be optimized over a wide range of depths.

Speed Limitations — The maximum speeds of underwater bodies are limited principally by the relatively high friction of water, power capability and cavitation. Cavitation limits the speed, depending upon depth, fineness ratio (the length to diam of the body) and fairness of the body under consideration. Cavity-running bodies may be developed eventually which can run beyond the cavitation limiting speeds but variable operating depth requirements make this a very difficult problem to overcome.

Underwater rocket and ramjet engines offer higher speeds for anti-submarine warfare weapons but they have less efficiency and range than engines using rotating machinery. Based upon the limiting power plant capacity which can be fitted inside a feasible hull, the maximum speed of an underwater body propelled by rotating machinery is about 80 kts for a 21-in. diam hull.

Considering a family of underwater bodies in which the rocket engines are as large as practicable—limited by the body diam and assuming chamber pressures attainable by solid rockets, the following table gives the limiting speeds for underwater rocket propelled missiles. It applies down to very great depths for solid rockets and only for shallower depths for liquid rockets and ramjet engines. A further characteristic of these power plants is that they are free from propeller cavitation limits at all depth. (See graph on opposite page.)

LIMITING SPEED TABLE

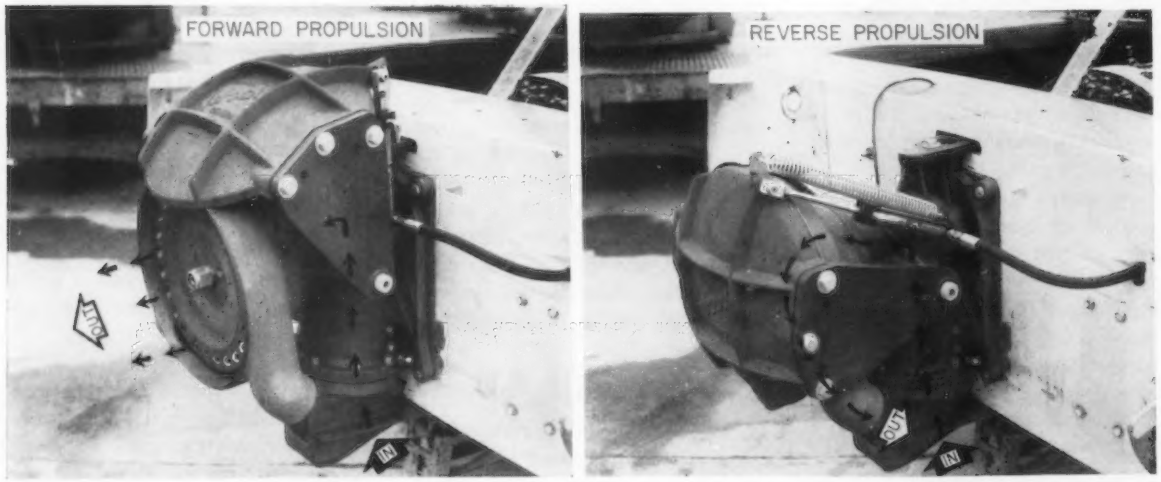
Velocity (knots)	900	640	450	320
Fineness Ratio	5	10	20	40

The fineness ratio is the length to diameter ratio.

Structural Considerations — To withstand high internal gas pressures and external water pressures, deep diving weapons must have relatively lightweight, extremely strong hulls. The Structural Materials Div. is presently supplying the experience and knowledge gained in developing materials and hardware for space vehicles to the problem of submerged structures. High strength-to-weight composites which meet outer space needs can also be utilized to obtain the structure weight-to-displacement weight ratios required for future anti-submarine warfare applications.

Rockets Afloat — Anti-submarine warfare operations are not limited to submersible craft and weapons. There will always be a need for high speed destroyers and other surface vessels. For speeds above and beyond the practical limits of propeller driven boats and ships (about 60 kts) the special type of water pump jet (Hydrocket) is showing promise.

Fundamentally, this engine is a centrifugal pump in which the radial flow impeller is closed at its periphery and is provided with a row of nozzles and the water is discharged axially, not to a volute, but rearward in the open air. Water is admitted into the system by a high-efficiency scoop which takes advantage of the ram energy of the water



HYDROCKET is prototype of jet surface-propulsion system. Engine is fundamentally a centrifugal pump. Exhaust gate is open for normal operations and water is discharged rearward in the atmosphere from canted nozzles. To "back-down," exhaust gate is closed and water is directed toward bow.

derived from the forward motion of the vessel. A duct, designed to reduce flow losses, leads the water into the eye of the pump impeller. Turning vanes in the duct elbows help to reduce losses by keeping the flow rectilinear. The bearing support vanes are canted slightly from the axial direction to give a rotational component to the water entering the impeller.

The nozzles are set at an angle from the axial direction (between 45 and 65 deg.) to cancel the major portion of the impeller peripheral velocity. The impeller is not contained in a casing and volute but is surrounded only by the atmosphere. This eliminates the large losses normally encountered in converting the high-speed discharge from the impeller into pressure head in the spiral volute and the losses from disc friction between the casing and the shrouds.

The water pressure in the impeller is restricted at the nozzle ring so that the pressure inside the impeller just ahead of the nozzle ring is high, corresponding nearly to that in a forced vortex. This pressure is converted to spouting velocity in the nozzles which is directed rearward and in the opposite direction to the impeller rotation. This results in axial thrust.

Since high rotative speeds do not cause a loss in propulsion efficiency, direct drive, high-speed turbo-machinery, or piston engines can be used to drive the impeller. The weight of the system can be reduced, inasmuch as no heavy reduction gearing is necessary. If the engine is installed with a downward inclination of the shaft, a lift component is developed from the total thrust, and the rooster tail discharge is suppressed.

In steering the vessel, a conventional rudder, swiveling unit, or jetavator rudder may be used. To back the craft, it is necessary only to reverse the thrust of the propulsion unit. To do this, a gate, similar to a Taintor Gate, is dropped over the discharge of the unit and the water is forced through nozzles pointing forward and downward in a bell casing surrounding the impeller.

The Hydrocket shows improvement over previous hydrojet surface propulsion systems because:

- Pump losses, which heretofore have limited the application of hydraulic jet propulsion, have been largely eliminated.
- The cavitation sensitivity of radial flow pump impellers is much less than that of marine propellers because of the low relative velocities at the eye of the impeller.
- The system arrangement lends itself to short, efficient ducting so that with good design, large masses of water can be handled, thus keeping jet-velocity ratios in the high efficiency region.

For Hydrofoils — In hydrofoil craft, the Hydrocket eliminates the need for extensive gearing and shafting required by propeller systems. Ducting and intakes can be incorporated in the hydrofoils and struts, thus keeping the appendage resistance to a minimum.

Since all elements of this system can be located at or above the keel of the ship, underwater damage to the propulsion system can be virtually eliminated. Repairs and maintenance can also be made with the ship in the water.

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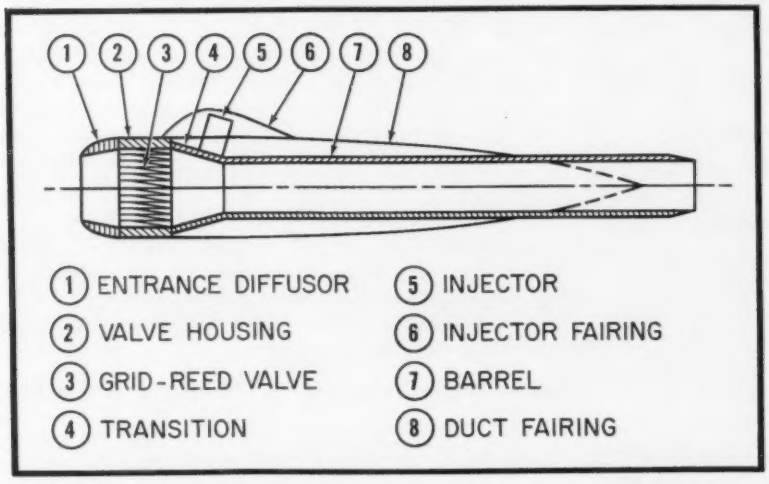
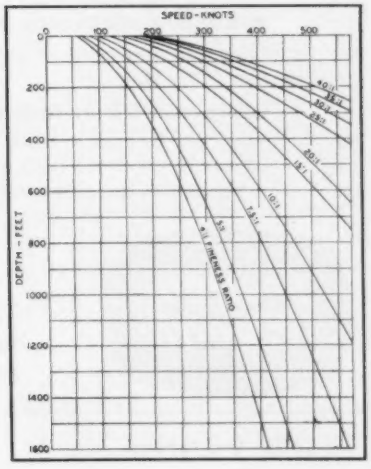


HYDROPULSE PROPULSION was Aerojet General's first attempt at adapting rocket techniques to underwater use. Hydroturbojet, Hydrocket and Hydroduct (ramjet) are current projects.

FINENESS RATIO (length to diameter relationship) restricts underwater speed and depth of most vehicles. Solid propellant rockets are free from propeller cavitation limits at all depths.



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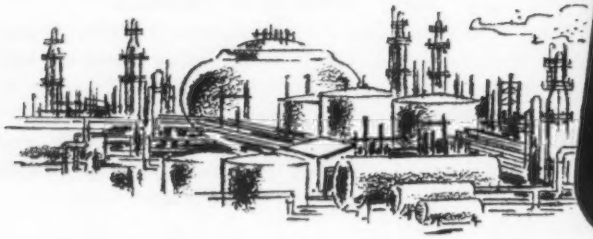

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Tactical Trainer for ASW

Fleet operational ASW simulator stages war games "in port"; Stresses functional coordination of surface, sub-surface, and air forces

by Howard J. Warnken, Vice President & General Manager,
Military Electronics Div., Daystrom, Inc.

The deadly effectiveness of submarines against surface craft is graphically documented in the annals of modern naval history. Today, the devastating potential of the elusive submarine has been extended further through nuclear propulsion and missile-launch capabilities. Hence, anti-submarine warfare (ASW) commands a high priority in current defense thinking.

Concurrently with improved equipment, ASW doctrine and techniques must be developed to perfect the functional coordination of surface, sub-surface, and air forces. Here, as in any tactical operation, training of commanders and associated personnel is the key to success.

Training under actual fleet operations and exercises involves a good deal of time and money. However, fleet operational ASW training can now be accomplished in large part "in port" through a comparatively simple and inexpensive training device known as the Action Speed Tactical Trainer (ASTT). This is a simulator developed by the Military Electronics Div., Daystrom, Inc., Archbald, Pa., jointly with the U.S. Naval Training Device Center, Port Washington, N. Y. The system has been in operation at the Navy's Fleet ASW School, San Diego, since early 1959.

Simulator system includes prepositioning indicators, helm units, dead reckoning tracers, projectors, plotting tables, and interconnection circuits. Up to a hundred officers and men located in ten separate combat information centers can train together on ASW tactics. The system trains naval personnel in radio-telephone voice procedures, Hunter-Killer (HUK) search and patrol, screen reorientation, and retiring search tactics. No attempt has been made to incorporate a means

ACTION SPEED TACTICAL TRAINER development is discussed by author Howard J. Warnken (right), V. P. and general manager, Military Electronics Div., Daystrom, Inc., with plant manager Richard E. Bennett.

Trainees are subjected to kind of situation they will encounter in action aboard ship.

of training sonar attack teams, "kills" therefore, must be decided purely on probability or percentile basis.

Practicing with ASTT develops the trainees' ability to respond quickly, and accurately to the same kind of situations they will encounter in action aboard ship. The system is equally useful in perfecting the skill of fleet units, already on duty under conditions most nearly approaching environmental conditions at sea. Frequently, an exercise is scheduled on the trainer as an in-port rehearsal for a forthcoming Anti - Submarine Warfare Exercise (ASWEX).

Officers ranging in rank from ensign to captain have been trained on the ASTT, as well as officers of allied nations. The Navy also credits the device with making sigficent contributions to tactical developments as well as expansion and perfection of basic ASW doctrine itself.

Realistic Simulation — In essence, the ASTT system involves 8 destroyers augmented by 4 helicopters, 2 fixed-wing aircraft, 2 submarines, and 1 convoy. Each destroyer is simulated by a 12-ft² room equipped with the facilities of a regular ship's bridge and Combat Information Center (CIC). Physical layout of the trainer also includes a 40 x 20-ft display and projection room and a helo/air room similar to the CIC booths. An electromechanical projection system shows relative positions of the convoy, destroyers, aircraft, and submarines on a 9 x 9-ft screen representing a 10,000 mi² ocean area. Also projected are scaled maps of land masses and sonobuoy locations.

Mock-up CIC rooms, have stations provided for the destroyer's normal complement of watch officers, communication and navigation officers, radar operators, and plotters. Each "destroyer" is equipped with a helm unit, radar scope, speed and course repeaters, dead-reckoning tracer table, air and sea plotting boards, air-status board, ASW-status board, multi-channel communication equipment, and other devices necessary for shipboard guidance and control.

The simulated bridge and CIC facilities give the same output as their regular counterparts. Equipment however is much simpler in design and construction. This fact alone has accounted for impressive savings in construction and maintenance.

Trainees are able to plot and change course and speed in accordance with orders received from the task-force commander and monitor all action from their radar scopes, course and speed repeaters, and dead-reckoning tracers. Speed and course information for each ship is fed by a multiplexing system from many different sources to the central-display room for plotting. Speed and course information is simultaneously exchanged among all ships. In effect, each training group is provided information it would normally receive if actually engaged with an enemy.

Instructor Mans Master Console—From his central location at the master console in the display room, the instructor monitors and controls the entire operation. At his disposal he has numerous controls, including a master radar scope, individual unit movement control switches, complete communication monitoring circuits, and an internal interphone system to each unit. Through selector switches he can select course and speed information from any helm unit, and read the course and speed of the selected craft on monitor course and speed dials.

Master control console faces the 9 x 9-ft coated-glass screen plotting board simulating a 100 x 100 nautical mile sea area at a scale 1 in./mi. Each helm unit—those in separate rooms as well as the prob-

MASTER CONTROL CONSOLE of Action Speed Tactical Trainer is manned by two instructors. Banks of communication-monitoring circuits are visible in left background.

lems room—is connected to an optical projector which moves a tiny spot of light on the screen in accordance with the course and speed set on the helm unit. Optical filters allow changing the color of the submarine projection lights to signify changing depth. A bank of target-intensity switches also enables the instructor to prevent targets from appearing on CIC room radar screens.

Before starting an exercise, the instructor can spot the individual craft in certain locations or formations on the glass screen through pre-positioning controls located on his console. From his central position he can also "look over the shoulder" of any particular group electronically, and give individual guidance as necessary. The multichannnel, multiplexed communications equipment allows him to talk directly to any indivdual, any group of trainees, or to all personnel simultaneously. Trainees, in turn, can talk privately to the instructor, or the instructor can listen in on the orders being transmitted to personnel in a particular CIC room.

At any time during an exercise, the instructor can stop the movement of all craft simultaneously. The problem can be analyzed and critiqued at that point, then operation resumed. At completion of problem, the entire course of action is retraced on plotting board. The instructor then holds a critique discussing the decisions made and action taken by participating units throughout the problem.

Typical ASW Exercise—At the outset, the instructor sets initial course and speed for each craft on its helm unit and pre-positions each craft at its starting location. Initial data is written on the status boards in the CIC rooms, and the Dead-Reckoning Tracer (DRT) tables are prepared for plotting.

Before the exercise begins, all participating officers and enlisted men are assembled in the display room for briefing by the instructors. At this point he explains the operational mechanics of the ASTT and reviews the objectives of various craft. Next, convoy commanders, screen commanders, and all others required for the problem are designated.

Radio-telephone procedure and codes are specified, and all other data pertaining to the situation—weather, time, tides, sunrise, sunset, etc.—is given either orally or in writing. Finally, specific elements contained in the operation order are reviewed.

Following this orientation, participants proceed to their respective rooms and stations. Normally, the Officer in Tactical Command (OTC), his staff, and flagship personnel occupy the same CIC room. Other ship commanders and their personnel are each assigned one of the other rooms.

Helicopter squadron officers operate their craft from the helo/air room, which is equipped with a radar scope, and controls for guiding all four helicopters. Fixed-wing aircraft, submarines, and convoy are controlled from speed-helm units positioned along one wall of the display-projection room.

With the information on hand, the OTC establishes formations, screens, and deploys the appropriate aircraft. Actual maneuvers start with the instructor informing the searching aircraft, for example, that he has a radar contact that quickly disappears from the radar scope. Normal HUK procedure begins to unfold with the OTC vectoring his helicopters and Search Attack Unit (SAU) to the contact area. The units stationed in the other CIC rooms translate OTC's orders into appropriate action.

Functional Coordination — As the exercise progresses, the instructor continues to feed intelligence information to the OTC and individual destroyer CIC rooms. This is accomplished by providing contacts to the individual ships, or simulating exterior intelligence data. Based on the changing situation, the OTC determines SAU deployment, and coordinates the tactical disposition of his entire HUK group.

Some students operate the electromechanical helm units which transmit electrical data to the DRT tables and ship's projector, to produce movement on the main screen simulating that of an actual ship. Others operate the helm units controlling simulated aircraft, convoy, or submarine projectors. Electrical data from the projectors is utilized in the radar system to produce the Plan Position Indicator (PPI) presentation.

Simultaneously, plotters in each CIC room chart their ship's course on the DRT table. Using radar information, they may also chart the course of the convoy and/or other craft. Communications between CIC rooms is maintained through simulated radio-telephone networks, convoy and screen commanders issuing orders and receiving reports on the specified channels. Information obtained on radio, radar, and DRT tables is noted in grease pencil on the appropriate plotting boards.

Meanwhile, in the display room the convoy commander, submarine commanders, fixed-wing aircraft commanders, and the instructor view position and progress of all craft on the big glass screen. Aircraft commanders at their helm units execute the search patterns specified by the screen commander from his CIC room. The pilots announce submarine contact, "fly" the aircraft over the submarine to allow the destroyers to obtain a radar fix on the target, and carry out all orders received from the screen commander by radio.

With an eye on the glass screen and master control azimuth and range indicator, the instructor monitors all craft. He serves as referee, judging the validity of contacts as noted by the aircraft commanders. Using switches on the master control console, he can remove targets when, in his opinion, they are put out of action.

Coordination of forces in the contact area is graphically displayed on the large display room plotting board, movement of indi-

Freeze of operations during exercises allows analysis and critique of situation

vidual units making up the complex being shown by the moving beams of light from the projectors. All individual craft movements are plotted on the rear of the glass screen in colored grease pencil.

Thus, the game is played, changing with each tactical move ordered by the OTC. From the instructor's central position, he can readily observe the effectiveness of the OTC's actions and orders. These decisions, and their ramifications, are also made vivid to any other personnel observing the exercise.

Besides the typical Hunter-Killer exercise described, the trainer can also handle convoy exercises, screening problems, sortie exercises, and simple two-ship/two-helicopter ASW problems.

Discussion and Critique—Possibly the greatest advantage of the ASTT is evidenced during the discussion and critique phases of the exercise. Upon completion of the problem, all participants are re-assembled in the big display room in front of the screen. Floodlights are turned on behind the screen, and the plots of the tactical action of individual units during the exercise are transferred to the front.

Ultraviolet lights in front of the screen make all the plotted lines glow. The entire action is indicated as an aid in illustrating the critique. Ideas of the OTC, destroyer commanders, pilots, and other participants are related on the spot. In this way, the pros and cons of a certain decision can be discussed immediately while the exercise is still fresh in everyone's mind.

Net result is that all members of the Hunter-Killer group can better learn what to expect from the OTC — and from one another — when they set out to sea.

Although 19 target projectors are in use in the ASTT presently in operation at San Diego, the projector rack is built to accommodate up to thirty units. Likewise, with an eye to future needs, provisions are incorporated within the system to accommodate up to 12 CIC rooms and 30 targets.

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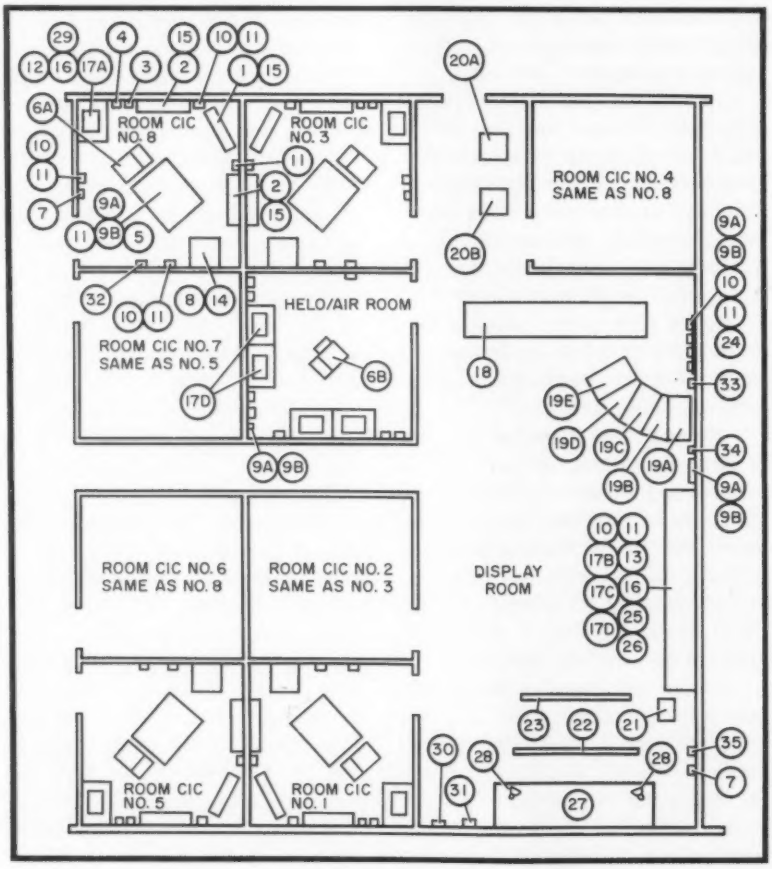
ACTION SPEED TACTICAL TRAINER

(Floor Plan Layout)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ROOM CIC NO. 3
ROOM CIC NO. 4 SAME AS NO. 8
HELO/AIR ROOM
ROOM CIC NO. 7 SAME AS NO. 5
ROOM CIC NO. 6 SAME AS NO. 8
ROOM CIC NO. 2 SAME AS NO. 3
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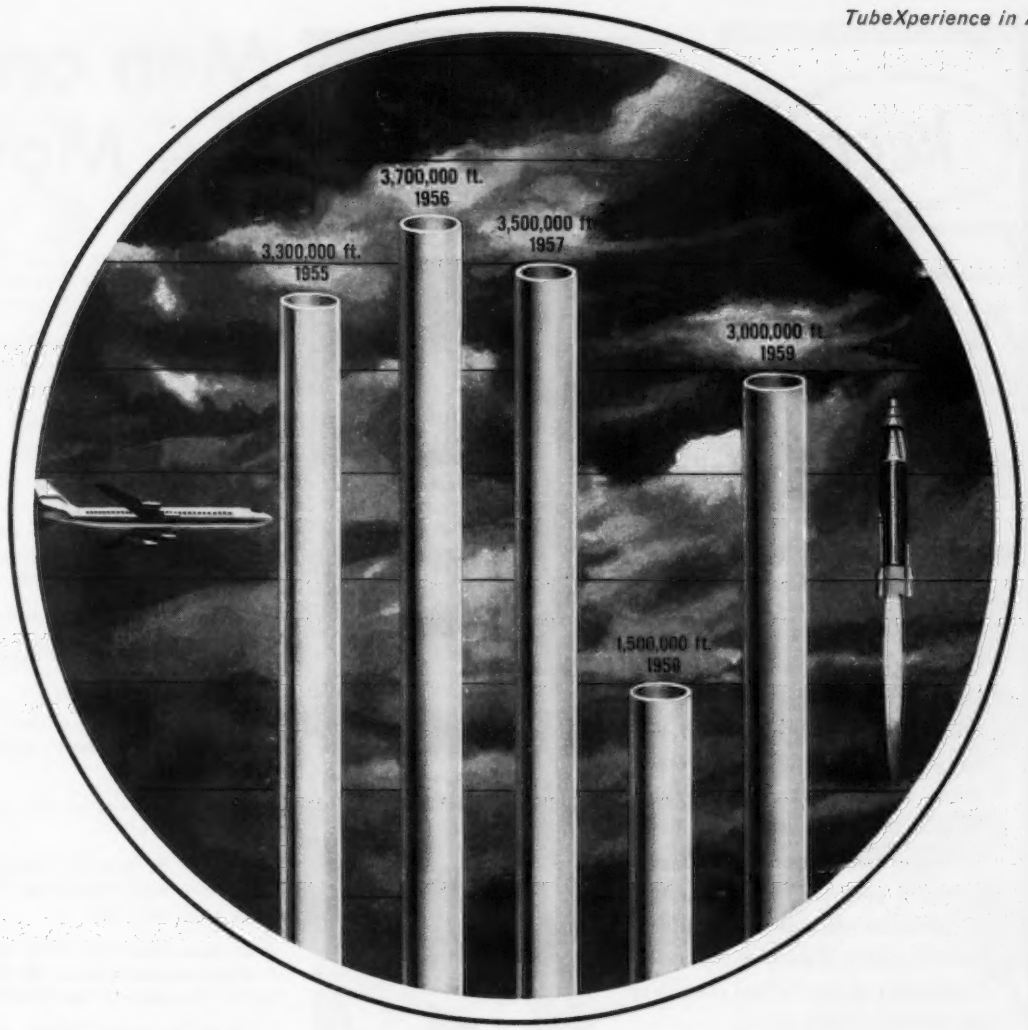
LEGEND

1 Air Plot MK6, MOD 2
2 Status Board MK5, MOD 3
3 Indicator, Ships Speed
4 Indicator, Course
5 Table, Dead Reckoning Tracer
6A Indicator, Azimuth and Range
6B Monitor, Azimuth and Range
7 Inter com. Remote Speaker Sta.
8 Summary Plot Board MK2, MOD 3
9A Terminal Box, Ampl. Output
9B Terminal Box, Ampl. Input
10 Speaker Assy., (R/T)
11 Receiver-Transmitter Facsimile
12 Table, Individual Helm Unit
13 Table, Helm Unit (Problems Room)
14 Table Stand, Summary Plot, MK2, MOD 3
15 Stand Assy., Status or Plotg. Board
16 Electronic Amplifier
17A Helm Unit, Ship
17B Helm Unit, Submarine
17C Helm Unit, Convoy
17D Helm Unit, Aircraft
18 Stand Assy., Projector
19A Console, Intercom., Master Station
19B Console, Wedge, Power Distr.
19C Console, Azimuth and Range Ind.
19D Console, Wedge, Projector Pattern Control
19E Console, Projector, Prepositioning Control
20A Master Equip. Bay No. 1
20B Master Equip. Bay No. 2
21 Amplifier Assy., (R/T)
22 Projector Screen
23 Ultraviolet, Fluorescent Fixture
24 Panel Assy., Communications Equip.
25 Panel, Communication Equip. (4-in-Line)
26 Panel, Communication Equip. (3-in-Line)
27 Plotters Platform
28 Floodlight
29 Junction Box, Helm
30 Main Power, CIC Distr.
31 Main Power, Display (Problems) Room Distr.
32 Power Distr., CIC
33 Power Distr., Console
34 Power Distr., Remote Sta.
35 Power Distr., Screen



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keeps in good shape...

ROEBLING AIRCORD

Roebling Aircord is made to exceed all applicable specifications for control cables. But this preformed, carbon steel cord gives you another, *extra* advantage . . . undesirable "constructional stretch" is reduced to insignificance during the manufacturing process. This means that the need for adjustments is minimal when Roebling Aircord is in service. Uniformity of control and *consistent* performance are assured.

Roebling carbon steel Aircord is made with galvanized or tinned finishes. You can order it in stock lengths or in complete assemblies with swaged terminals that develop the full catalog strength of the cord. Roebling also supplies stainless steel Aircord.

For details on Aircord and another industry favorite, Roebling Lock-Clad® (aircraft cable with aluminum tubing swaged around it), write to Roebling's Wire Rope Division, Trenton 2, New Jersey.

ROEBLING

Branch Offices in Principal Cities
John A. Roebling's Sons Division
The Colorado Fuel and Iron Corporation

Men on the Move

John J. Landers
Nortronics

JOHN J. LANDERS named Manager of Product Sales for Gyroscopes for Nortronics' Precision Products Dept.

DR. WARREN N. ARNQUIST appointed assistant to the director of advanced research for Douglas Aircraft Co.

LEROY R. BARR appointed general manager of the Lear-Romec Division of Lear, Inc.

RICHARD BLYTHE and DAVID WILSON appointed project manager and chief design engineer, respectively, for cryogenics by Hydro-Aire Co.

HARRY T. BRIERLY appointed vice president, aircraft guidance systems and missile component sales for Astrex, Inc.

Grant E. Frezieres
Superweld

GRANT E. FREZIERES named director of research and engineering at Superweld Corp.

W. D. BRYSON elected vice president of Solar Aircraft Co.

PHILLIP N. BUFORD joined Page Communications Engineers, Inc., as senior staff engineer.

James E. Starr
Allegany

DR. T. J. BULAT appointed manager of sonic engineering by the Pioneer-Central division of the Bendix Corp.

JAMES E. STARR joined Allegany Instrument Co., as research director.

C. T. BUTLER appointed director; FRED M. HAKENJOS appointed director of operations; WILLIAM E. HOWELL appointed director of contract administration, and ALEXANDER F. GIACCO appointed director of sales development, Chemical Propulsion Div., Hercules Powder Co.

John T. McGraw
Vard Div.

JOHN T. MCGRAW named director of engineering for the Vard Div., Royal Industries, Inc.

JOSEPH E. CALLAHAN named vice president-sales of Huck Mfg. Co.

J. L. CARNES appointed manager, advanced planning at Thiokol's Rocket Operations Center.

Robert E. Strasser
Harvill

RICHARD S. CESARO named vice president-Corporate Planning, Research and Development of Autometric Corp.

ROBERT E. STRASSER appointed manager of Technical Service by Harvill Corp.

A. L. Lisle
Control Dynamics

S. Edward Franklin
Metals & Controls

Eugene A. Jackson
Astrosystems

D. C. Arnold
Alpha Corp.

A. L. LISLE named general manager of Control Dynamics Corp.

S. EDWARD FRANKLIN named chief engineer by Metals & Controls Inc.

CHARLES R. PLUM appointed Director of Marketing and Customer Services by Amcel Propulsion, Inc.

CHARLES E. REES, JR., appointed Director of Research for Actuation Research Corp.

H. P. ROBERTS named general manager of the Siegler Corp.'s Space Systems Technology Group.

WILLIAM H. ROBERTS to head General Electric's High Reliability engineering effort for solid tantalum electrolytic capacitors.

JOHN ROGERS appointed Production Manager at Silicon Transistor Corp.

JOHN L. ROBERTS appointed Manager of the Space Technology Div. Quantatron, Inc.

EDGAR M. SHURTLEFF appointed Director, Research and Development by Special Devices, Inc.

DR. SEYMOUR SEIGEL appointed to technical staff of Dynamic Science Corp.

DONALD SPOONER named project engineer at Electronic Development Corp.

PARIS H. STAFFORD elected Vice President-Engineering by Permanent Filter Corp.

WAYNE D. STINNETT appointed Manager, Special Projects Div. of Aerojet's Liquid Rocket Plant.

RICHARD J. STONE named R & D supervisor in delay line section of Corning Glass Works.

GEORGE R. TALLENT named Program Manager for the Motorola-Autonetics Minuteman Reliability Program.

EUGENE A. JACKSON appointed Chief Scientist for advanced research at Astrosystems, Inc.

D. C. ARNOLD appointed Vice President-Sales for the Alpha Corp.

GIFFORD K. JOHNSON named executive vice president of Chance Vought Aircraft.

CHARLES K. KRILL appointed plant manager of the Burbank Branch of Librascope Div., General Precision, Inc.

DR. DILIP K. DAS named project manager and DR. LEWIS R. KOLLER named research associate at National Research Corp.

LOVELL LAWRENCE, JR., appointed executive engineer, Chrysler Corp.'s Advanced Projects Organization.

FRANK W. LEHMAN elected Executive Vice President of Space Electronics Corp.

GEORGE R. LEONARD appointed General Sales Manager of Twin Coach Co.

WILLIAM J. MONAHAN appointed Chemical Engineer at Silicon Transistor Corp.

ROBERT A. NEWMAN appointed New Product Manager of Wheelock Signals, Inc.

DR. SHIGEO OKUBO named Manager of Gyro Platforms, Precision Products Dept. of Nortronics.

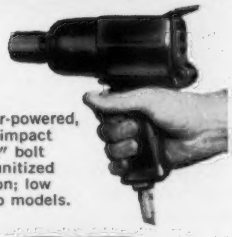
DOUGLAS D. ORDAHL named Manager of United Technology Corporation's Propellant Development Branch.

DREW W. PERKINS appointed Engineering Director of the Beryllium Corp.

HERBERT W. THODE named General Sales Manager by The Electric Specialty Co.

STUART E. WEAVER and HARRY B. HORNE elected vice presidents of The Marquardt Corp.

2
NEW
HIGH PERFORMANCE TOOLS
JOIN
AIRETOOL
LINE...



1
Rugged, air-powered, reversible impact wrench; ½" bolt capacity; unitized construction; low torque; two models.

2
400-T sheet metal tapper; runs at 400 rpm; rugged construction; reversible; muffled air motor; lightweight, easy to handle.

Where production demands are highest, you'll find Airetool fastening and production tools meeting or exceeding requirements, and the new 625 and 626 impact wrenches and 400-T tapper are no exceptions. Airetool's complete line of quality, job-proven, pneumatic production tools includes nutsetters, screwdrivers, drills and grinders. When you want production . . . you need Airetool.

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EUROPEAN PLANT: Vlaardingen, The Netherlands.

Circle 19 on Inquiry Card

Men on the Move

Robert W. Mayer
G. E.

G. Robert Jacob
Monitor Systems

Everett Babbe
Temptron

DR. HAROLD V. HANCE has joined the Systems Research Center of Lockheed Electronics Co.

NEIL L. HANSON appointed Vice President-Marketing of Permanent Filter Corp.

RAYMOND H. HELLER of Robertshaw-Fulton's Aeronautical and Instrument Div. elected assistant vice president.

ROBERT L. HIRSCH appointed assistant to vice president, at Aerojet's Solid Rocket Plant.

ORIEN L. HOGAN appointed senior representative at Huntsville for Rocketdyne.

ROBERT W. MAYER named Manager-Engineer for the General Electric Ordnance Dept.

HERMAN L. DULBERG appointed Chief Mechanical Engineer at Radiation Dynamics, Inc.

WILLIAM J. GAGNON appointed national sales manager for Hughes Aircraft's semiconductor div.

HAROLD D. GERMANN appointed Manager of Government Operations for Thiokol's West Coast Office.

JAMES H. GREEN, JR., appointed Director of Space Communications Division of the Alpha Corp.

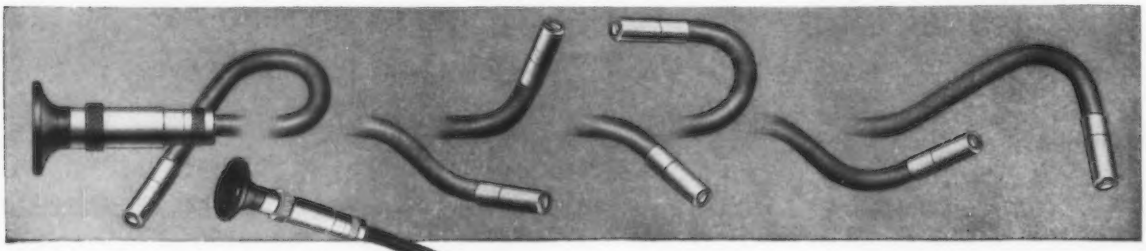
G. ROBERT JACOB has joined Monitor Systems, Inc., as project manager.

EVERETT BABBE appointed chief engineer for Temptron, Inc.

H. S. CHRISTENSEN named Marketing Manager for general aviation products by Bendix Radio Div.

BORIS COHEN appointed division manager, Anti-Submarine Warfare Div., and SANTO SCIBILIA appointed division manager, Passive Detection Div. by Loral Electronics Corp.

JOSEPH L. COMER appointed marketing manager of the Martin Company-Baltimore's Electronics Division.



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FOR visualization in inaccessible curved areas where a flexible instrument capable of adapting itself to irregular contours is required.

Fiber Optic Borescopes are equipped with focusing eyepiece and fixed or movable objective as required. Illumination can be provided by a flexible fiber optic light carrier with an external light source or an annular fiber optic light carrier attached to the image carrier. Fiber optic light carriers are particularly advantageous for transmission of intense cold light to inaccessible or hazardous areas.

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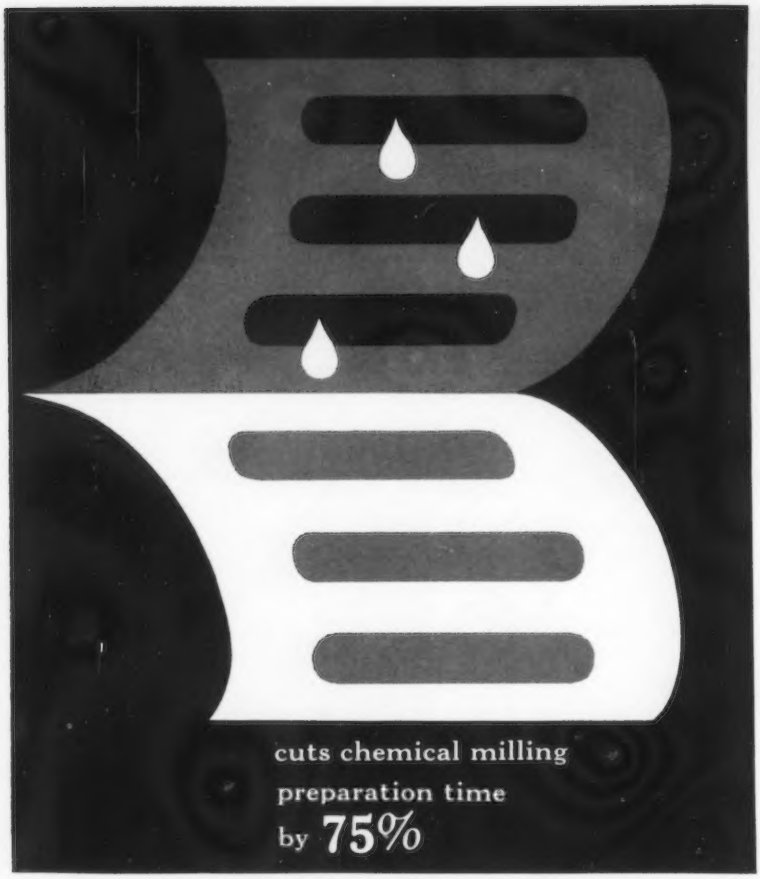

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7300 MYLAR MASKING TAPE

■ Here is a pressure-sensitive tape that will save time and money in your chemical milling operations. Mystik No. 7300 Mylar tape is quickly and easily applied to the surface to be masked off, and can be put on in ¼ of the time it takes to mask by spray-coating. No. 7300 not only saves valuable time, it allows for pin-point milling accuracy. The reason is the tough silicone adhesive. It grips ferrous and non-ferrous metals tightly during the entire milling process and shows excellent resistance to etching solutions. Thus, accurate milling is assured, right to the masked edge.

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MYSTIK ADHESIVE PRODUCTS, INC.
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Circle 39 on Inquiry Card

Worth Asking For

Special Purpose Motors
Facilities and capabilities brochure on special purpose motor manufacturer.—*Kollsman Motor Corp.*
Circle 67 on Inquiry Card for more data

Cut Drawings Cost
Booklet on Varityper for type composition.—*Varityper Corp.*
Circle 68 on Inquiry Card for more data

High Pressure Valves
Brochure details high pressure valve and fitting designs.—*Combination Pump Valve Co.*
Circle 69 on Inquiry Card for more data

Magnesium Finishing
Folder on finish systems for magnesium.—*Brooks & Perkins, Inc.*
Circle 70 on Inquiry Card for more data

Bonded Lubricant Coating
Characteristics of bonded lubricant coating for ferrous surfaces described in data sheet.—*Alpha-Molykote Corp.*
Circle 71 on Inquiry Card for more data

Blast Cleaning
Blast cleaning barrels described in bulletin (No. 706). — *Pangborn Corp.*
Circle 72 on Inquiry Card for more data

Electro-Magnetic Relays
Catalog showing complete line of electro-magnetic relays. — *Potter & Brumfield Div., American Machine & Foundry Co.*
Circle 73 on Inquiry Card for more data

Mechanical-To-Electrical Transducer
Descriptive treatise on the REGOHM Transducer, component used for the control of such quantities as position, tension, speed, weight, and others.—*Electric Regulator Corp.*
Circle 74 on Inquiry Card for more data

Chemicals For Optical Use
Brochure lists high purity halides. —*American Fluoride Corp.*
Circle 75 on Inquiry Card for more data

Sheet Metal Fabricators
Brochure on facilities and capabilities.—*Cutler Metal Products Co.*
Circle 76 on Inquiry Card for more data

Coaxial Cable Connecters
Brochure describes new connecters for aluminum sheathed, high frequency coaxial cables.—*Phelps Dodge Copper Products Corp.*
Circle 77 on Inquiry Card for more data

Air Compressors
Packaged air compressors rated at 25, 50, 75 or 100 hp.—*Clark Bros. Co.*
Circle 78 on Inquiry Card for more data

Plastic Pressure Vessels

Technical bulletin (140) on filament-wound reinforced plastic for high pressure storage vessels.—*Lamtex Industries Inc.*

Circle 79 on Inquiry Card for more data

Automatic Circuit Analyzer

Brochure describes new Automatic Circuit Analyzer for both AC and DC testing of wiring harness and electrical cabling.—*Dit-Mco, Inc.*

Circle 80 on Inquiry Card for more data

Plasma Spraying

Brochure describes the plasma spraying process, fabrication of parts and shapes of previously "unworkable materials," and the depositing of carbide hard facing. — *Plasma Systems Div., Schori Process Corp.*

Circle 81 on Inquiry Card for more data

Glass Fiber Cushion

Bulletin on plastic resin bonded, fine glass fibers, that can be molded or fabricated.—*Glass Products, Inc.*

Circle 82 on Inquiry Card for more data

Nylon And Molybdenum

Bulletin on molding compound of nylon and molybdenum disulphide.—*Polymer Corp.*

Circle 83 on Inquiry Card for more data

Ion Thrust Studies

Paper titled "Ion Thrust Studies at GHVA."—*Goodrich-High Voltage Astronautics.*

Circle 84 on Inquiry Card for more data

Motorpumps

Custom-designed motor pumps for aircraft, missiles and space craft featured in new brochure.—*Vickers Inc.*

Circle 85 on Inquiry Card for more data

Photomechanisms

Brochure describes instrumentation for rapid capture and display of data.—*Photomechanisms, Inc.*

Circle 86 on Inquiry Card for more data

Electro-Hydraulics

Bulletins describe precision components and control systems for aerospace industries.—*Sanders Associates, Inc.*

Circle 87 on Inquiry Card for more data

Flaw Finding

Bulletin (No. 130) describes single frequency non-destructive inspection equipment for finding flaws in nonferrous, non-magnetic metals.—*Magnetic Analysis Corp.*

Circle 88 on Inquiry Card for more data

Penetrant

A free trial aerosol can of a new lubricant for freeing tight, rusted or seized parts.—*Whitmore Mfg. Co.*

Circle 89 on Inquiry Card for more data

Accelerometer-Amplifier

Bulletin describes accelerometer-amplifier system for measuring shock and vibration data. — *Columbia Research Lab.*

Circle 90 on Inquiry Card for more data

Metrology Training

Pocket size brochure describes products and services in instruments and training.—*Metrolonics, Inc.*

Circle 91 on Inquiry Card for more data

Reusable Explosive Valves

Illustrated bulletin describes new series of Conax Con-O-Cap Reusable Explosive Valves. — *Explosive Products Div., Conax Corp.*

Circle 92 on Inquiry Card for more data

Blast Cleaning

Brochure on push-button controlled Rotoblast Table-Rooms. — *Pangborn Corp.*

Circle 93 on Inquiry Card for more data

A SUGGESTION *to engineers looking for broader responsibilities in the jet engine field—*

Our current programs are aimed at creating next-generation systems throughout the power spectrum of military and commercial turboshaft and turbojet engines. Our business plans are aggressive. By giving you broader responsibilities we improve our own growth plan. We'd welcome a chance to learn about your desire for more responsibilities in any of the following areas:

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- Resident Air Force Inspection
- Write for Facts About Fenn. The Fenn Manufacturing Co., Newington, Connecticut.

Circle 23 on Inquiry Card

Worth Asking For

CRYOGENIC STORAGE VESSELS

Brochure describes design of double-wall storage vessels, insulation systems, materials of construction and accessories.—*Chicago Bridge & Iron Co.*

Circle 94 on Inquiry Card for more data

ALUMINUM FORGING

Brochure reviews the production of all types of aluminum forgings.—*Harvey Aluminum.*

Circle 95 on Inquiry Card for more data

HIGH PRESSURE COMPRESSORS

Catalog on oil free gas booster compressors capable of boosting bottled gas to pressures as high as 15,000 psig. — *Haskel Engineering & Supply Co.*

Circle 96 on Inquiry Card for more data

CHEMICAL CLEANING

Pamphlet describes importance and methods of chemically cleaning equipment necessary to missile launching.—*Dow Industrial Service*

Circle 97 on Inquiry Card for more data

NUCLEAR RADIATION

"Minimizing the Effects of Nuclear Radiation on Electronic Equipment," Bulletin (ETD 2564).—*General Electric Receiving Tube Dept.*

Circle 98 on Inquiry Card for more data

EXCITATION CIRCUITS

Bulletin (PT-50) contains detailed information, of particular interest to designers of equipment for military application.—*General Electric Power Tube Dept.*

Circle 99 on Inquiry Card for more data

MISSILE/SPACE DIRECTION

Brochure explains non-profit organization which assists the Air Force in scientific and engineering planning on missile and space programs.—*Aerospace Corp.*

Circle 100 on Inquiry Card for more data

INDUCTION HEATING

Articles on applications, research and production involving induction heating.—*Lepel High Frequency Laboratories, Inc.*

Circle 101 on Inquiry Card for more data

HIGH TEMP TESTING

Booklet on TM-1 Auto-Dynamic elevated temperature test machine.—*The Marquardt Corp.*

Circle 102 on Inquiry Card for more data

FUEL COKER

Information on the CFR-ASTM Luminometer and Fuel Coker.—*Erdco Engineering Corp.*

Circle 103 on Inquiry Card for more data

HIGH TEMP PLASTICS

Article on successful bonding of flame and heat resistant intumescent coatings to plastics. — *Continental-Diamond Fibre Corp.*

Circle 104 on Inquiry Card for more data

GSE

Brochure lists facilities and capabilities of firm engaged in testing and ground support engineering and construction.—*The Stevens Co.*

Circle 105 on Inquiry Card for more data

SILICON TRANSISTORS

Booklet on silicon planar transistors and diodes.—*Fairchild Semiconductor Corp.*

Circle 106 on Inquiry Card for more data

ELECTROMAGNETIC INTERFERENCE

Details of test unit for detection, measurement and analysis of electromagnetic interference.—*Norair Div., Northrop Corp.*

Circle 107 on Inquiry Card for more data

SPACE SIMULATION

Facilities for aircraft, missile and human factor research described in bulletin.—*Chicago Bridge & Iron Co.*

Circle 108 on Inquiry Card for more data

COPPER-CLAD PLASTICS

Bulletin describes copper-clad laminated plastics.—*Taylor Fibre Co.*

Circle 109 on Inquiry Card for more data

COMPACT MOBILE RADIO

Bulletin (ECR-870) on line of compact, economy two-way radio equipment. — *General Electric Communications Products Dept.*

Circle 110 on Inquiry Card for more data

ELECTRICAL RESIN

Brochure lists properties and data for "Scotchcast" brand electrical resin No. 241.—*Minnesota Mining & Manufacturing Co.*

Circle 111 on Inquiry Card for more data

SELF-LOCKING FASTENERS

Design manual on reduced dimension, lightweight types of self-locking fasteners.—*Elastic Stop Nut Corp. of America*

Circle 112 on Inquiry Card for more data

POLYFORM DESIGN

Data sheet describes methods of forming metal enclosures in one piece.—*Barber-Colman Co.*

Circle 113 on Inquiry Card for more data

RADIATION ALARM SYSTEM

A radiation warning system for any area where radioactive materials are stored, handled or transported is described in Bulletin GA-2.—*Nuclear Measurements Corp.*

Circle 114 on Inquiry Card for more data

CONTROLLED TEMPERING

Bulletin (D-61) describes furnaces used for atmosphere tempering, annealing, and stress relieving.—*Ipsen Industries, Inc.*

Circle 115 on Inquiry Card for more data

BERYLLIUM COPPER STRIP

Bulletin (No. S-1100-A) on Beryllium copper strip products. — *The Beryllium Corp.*

Circle 116 on Inquiry Card for more data

RATE GYROS

Booklet contains concentrated engineering discussion on angular velocity sensors of a rate gyroscopic type.—*R. C. Allen Aircraft Instrument Div.*

Circle 117 on Inquiry Card for more data

TIMING MOTORS

Condensed catalog on timing motors and time and torque controls.—*Haydon Div. of General Time Corp.*

Circle 118 on Inquiry Card for more data

CAPACITORS

Bulletin describes capacitors for silicon controlled rectifier applications.—*General Electric Co.*

Circle 119 on Inquiry Card for more data

BRUNSWICK FACILITIES

Folder describes the design, testing, and manufacturing facilities of missile and aerospace products.—*Defense Products Div., Brunswick Corp.*

Circle 120 on Inquiry Card for more data

CHAMFERING GRINDERS

Bulletin on deburring and chamfering grinders.—*Michigan Tool Co.*

Circle 121 on Inquiry Card for more data

SEAL SPECS

New 54-page catalog lists official U. S. specs for a wide variety of adhesives, coatings and sealers.—*Minnesota Mining & Manufacturing Co.*

Circle 122 on Inquiry Card for more data

HIGH TEMP-DRY LUBE

Brochure details new high temperature dry lubricant.—*General Magnaplate Corp.*

Circle 123 on Inquiry Card for more data

FOIL WELDING

Information on the control of process variables for the successful welding of foil.—*Air Reduction Co., Inc.*

Circle 124 on Inquiry Card for more data

ENGINEERING CAPABILITY

Brochure describes special-purpose motors and facilities of pioneer motor designer. — *Kollsman Motor Corp.*

Circle 125 on Inquiry Card for more data

MODULAR RELAY

Bulletin describes 4, 6 and 12 pole wire contact, plug-in relays.—*Wheelock Signals, Inc.*

Circle 126 on Inquiry Card for more data

MINIATURE CAPACITORS

Booklet describes polystyrene miniature capacitors.—*Efcon, Inc.*

Circle 127 on Inquiry Card for more data

POTENTIOMETERS

A summarization of leadscrew and wormgear actuated potentiometers.—*Bourns, Inc., Trimpot Div.*

Circle 128 on Inquiry Card for more data

BASIC SWITCHES

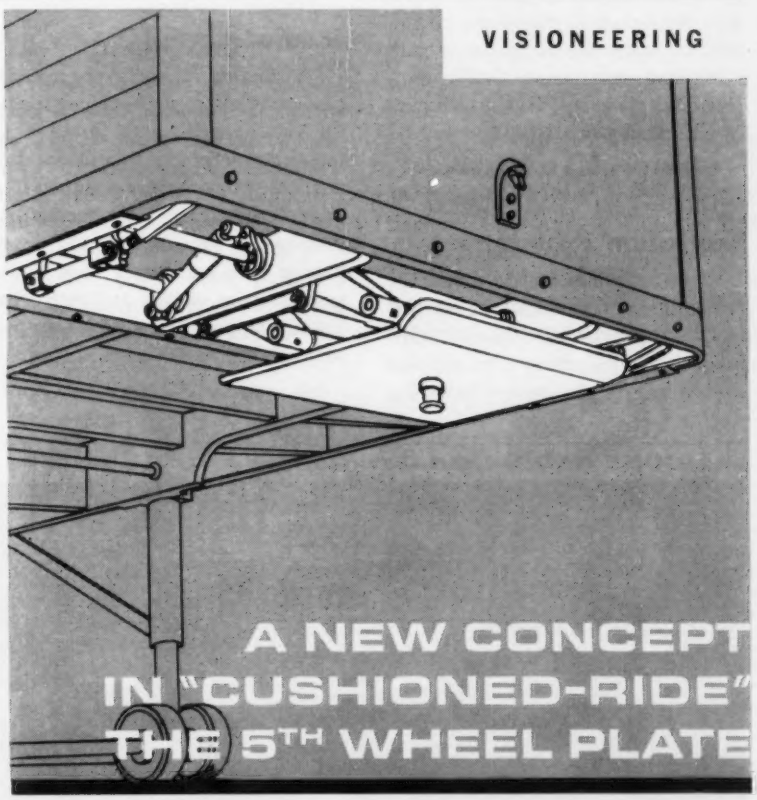
Catalog (#110) of basic precision switches.—*Control Co. of America, Control Switch Div.*

Circle 129 on Inquiry Card for more data

SYNCHRO TESTING

Leaflet describes precision equipment for testing synchros.—*General Precision Inc., Kearfott Div.*

Circle 130 on Inquiry Card for more data



■ Unlike our other heavy-duty, soft-ride suspension systems, the 5th Wheel Plate utilizes torsion bars instead of springs. This unit was designed and patented primarily for trailers hauled by tractors and provides the maximum shock resistance for the most fragile of cargoes, regardless of road or terrain.

At present our patented 5th Wheel Plates are in military service in various ground support operations, but there are many practical commercial applications.

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Circle 24 on Inquiry Card

New Materials

Resin Coatings

Cured Dapon diallyl phthalate resins provide insulation and dimensional stability for electrical and electronic equipment. After curing, these resin coatings possess excellent resistance to moisture, chemicals, corrosive gases, fungus, weathering and aging over a wide temperature range.—Food Machinery & Chemical Corp.

Circle 131 on Inquiry Card for more data

Tantalum Powder

New tantalum powder improves fabrication and performance of electrolytic capacitors. Designated SGP, powder enables pellets to be pressed to lower green densities, lowering dissipation and increasing capacitance per gram.—National Research Corp.

Circle 132 on Inquiry Card for more data

Insulating Fill

Insulating fill for cryogenic applications offers thermal conductivity values significantly lower than materials currently in use for this purpose. Completely synthetic, it is a free-flowing powder, free of explosion or fire hazard and compatible with commonly used liquid gases such as oxygen and hydrogen. Trade name is Micro-Cel.—Johns-Manville Celite Div.

Circle 133 on Inquiry Card for more data

Coolant

New coolant-dielectric fluid offers extreme low-temperature capabilities in liquid-cooled electronic equipment. Trademarked Coolanol 35, the fluid is thermally stable at temperatures as high as 400 deg F. —Monsanto Chemical Company.

Circle 134 on Inquiry Card for more data

Epoxy Laminate

New NEMA G-10 glass fabric epoxy laminate is for printed circuit boards in ground and airborne computers where performance requirements are particularly exacting. Fabricated parts made from it show that "haloing" and edge-lifting are virtually eliminated, allowing closer and more intricate hole punching. This provides better quality plated-through holes and superior circuit reliability under humid conditions. — Continental-Diamond Fibre Corp.

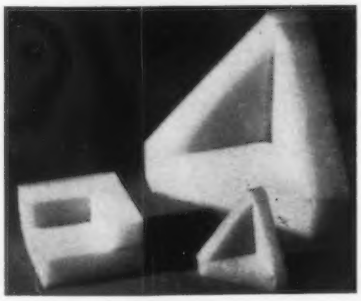
Circle 135 on Inquiry Card for more data

Silicone Potting

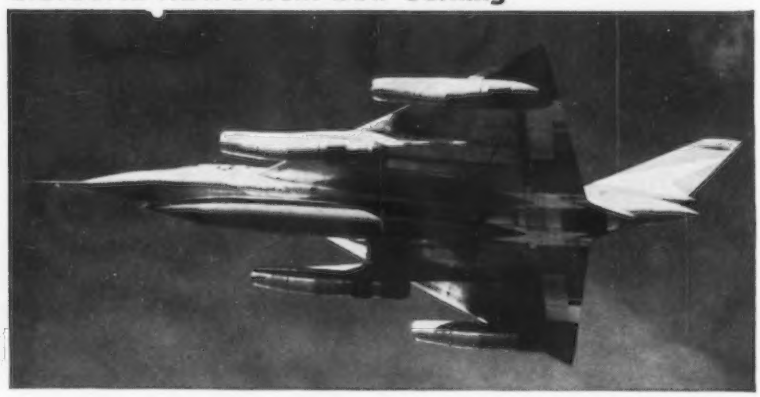
Silicone potting and embedding compound provides mechanical and dielectric protection for electronic components and assemblies. Called LTV 602 (low temperature vulcanizing) clear silicone potting compound, it cures at 70° to 80°C to a flexible, resilient solid.

LTV-602 provides excellent protection against shock, vibration, moisture, ozone, corona, and other environmental hazards of the space age. Unlike jelly-like potting compounds, the cured material is self-supporting and non-flowing.—Silicone Products Dept., General Electric Co.

Circle 136 on Inquiry Card for more data



SILICONE NEWS from Dow Corning



Helping a Hustler Hustle

A simple "short" due to insulation failure can ground or make impotent the B-58 Hustler, this nation's present promise of devastating reprisal. That's why Convair engineers specified Silastic®, the Dow Corning silicone rubber, as the insulation for power and control cable.

One moment this super-sonic guardian is streaking through the arctic cold and ozone-containing atmosphere above 50,000 feet . . . minutes later it may be standing in the oven heat of a desert landing strip . . . tough environments for any rubber insulating material — except Silastic.

Write to Dept. 0316 for information

first in silicones

Dow Corning CORPORATION
MIDLAND MICHIGAN

Prepregs

New line of "prepregs" will enable molders of plastic laminate to eliminate a time-consuming fabricating operation and will ensure more efficient and effective use of plastic materials. Various types of fabrics and fillers — impregnated with polyester resin, epoxy resin, high temperature phenolic resin, and silicone resin—are the first of this new group of products. Many applications of prepregs are for aircraft and missile components.—Micarta Div., Westinghouse Electric Corp.

Circle 137 on Inquiry Card for more data

Protective Clothing

Special polyvinyl cloth has been developed for protective clothing used in handling liquid-fueled rockets and missiles. Clothing made from these materials has been tested and accepted for handling liquid oxygen, fuming nitric acid and hydrogen peroxide at Pacific Coast installations.—Jomac Inc.

Circle 138 on Inquiry Card for more data

Packaging Material

New type of internal cushion packaging material, called Resilo-Pak, is an expanded polystyrene. It retains its physical characteristics from −80 deg to 165 deg F, is dimensionally stable at normal temperatures, has a neutral pH, is nonabrasive, non-dusting and nonhygroscopic.—Armstrong Cork.

Circle 139 on Inquiry Card for more data

Plastic Rocket Motors

High-strength, lightweight, reinforced-plastic materials can be used to manufacture rocket motor cases. Second stage Polaris will be made of "Hystran," a new filament-wound, fiber-glass reinforced plastic material. The strength and weight characteristics of "Hystran" result in a dramatic weight reduction. Early results show at least 50 per cent reduction over steel cases previously used.—Lamtex Industries.

Circle 140 on Inquiry Card for more data

Paste Solder

A new paste solder is designed for tough-to-solder stainless steel materials. This development marks the first time a paste solder material has combined an acid type flux with an easily removable residue. Simple dipping in water while hot or soaking in water while cold will remove all active residual particles after soldering. — Fusion Engineering Magnesium Cleaner.

Circle 141 on Inquiry Card for more data

Transparent Resin

Silicone encapsulating material permits visual inspection of circuits and components within potted, embedded or encapsulated assemblies. Designated Sylgard 182 resin, it is applied as an almost colorless liquid. Cures in place to form a transparent mass having outstanding dielectric properties, good moisture resistance, flexibility and toughness.—Dow Corning Corp.

Circle 142 on Inquiry Card for more data

Fluxless Solder

Low temperature fluxless solder, called Tin-A-Lum, melts at extraordinary low temperature. This eliminates danger of metal destruction under heat. Can be used on aluminum and its alloys, zinc, tin, pewter, magnesium and castings.

After a decade of experimentation and exhaustive tests, the solder was perfected to join dissimilar metals. It uses a soldering iron or a light flame and has no flux. It has proven to be of such tensile strength that it can even replace welding or brazing.—Metals for Industry Inc.

Circle 143 on Inquiry Card for more data

Magnesium Cleaner

New cold magnesium cleaner and bright dip is a dry powdered cleaner. Used cold, it will remove the oxidation products, foreign matter and stains from the surface of magnesium for spot welding or welding.—Bernard Chemical Products Co.

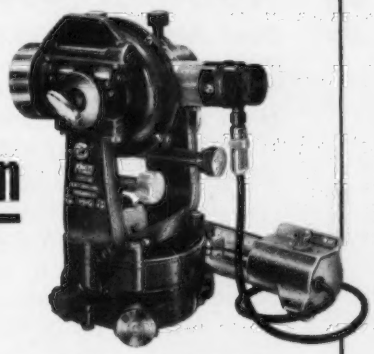
Circle 144 on Inquiry Card for more data

INERTIAL GUIDANCE

Represents one of many applications of

Autocollimation

to solve Alignment Problems of a highly precise nature.



The KERN DKM2

When equipped with the new No. 356 Autocollimating Eyepiece, this famous one-second theodolite has a total magnification of 23x and an operating range from zero to at least 100 feet for autocollimation.

Write for technical data and specifications

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these advantages of Tayloron* Reinforced Plastics in high-performance assemblies

6 **High strength-to-weight ratio.** In terms of weight, reinforced plastics are considerably stronger than most metals. Moreover, their strength characteristics may be directed where stresses demand. In filament or tape wound shapes, highest properties may be obtained.

5 **Comparative rigidity in cured condition.** This property prevents the reinforced plastic part from bulging or otherwise deforming when high pressures or other stresses are present. Thus original tolerances can be maintained under adverse operating conditions.

4 **Excellent corrosion resistance.** High resistance to both atmospheric and chemical corrosion is a feature of reinforced plastics. This is particularly important in structural members where corrosion could generate failure locations.

3 **Low heat transfer.** This, under extremely high temperatures, makes Tayloron ideal for protecting structural members in missiles.

2 **Good ablation qualities.** The capacity to keep on performing their basic function despite loss of some of their structure is an important characteristic true of some reinforced plastics. Tayloron materials offer the additional advantages of dissipating energy and thus reducing stresses on other members.

1 **Ease of fabrication.** A wide variety of shapes may be made to close dimensions by molding, laminating, or winding of filament or tape. Tayloron reinforced plastics are readily fabricated and machined.

How Taylor Can Help You

In your designing of components and assemblies, consult our Advanced Materials Division on how to choose the best material and minimize the cost in reinforced plastics. Taylor can supply complete fabricated assemblies—or materials for any test and evaluation program. Special Tayloron materials have been developed for many specialized applications. Write the Advanced Materials Division outlining your specific problem. Taylor Fibre Co., Norristown 50, Pa.

*Trade name for Taylor Fibre's space, missile and astronautic materials

Taylor
REINFORCED PLASTICS VULCANIZED FIBRE

Composite laminates • Metallic and nonmetallic materials laminated with plastic resins in many combinations and many forms • Vulcanized fibre in sheet, roll or fabricated parts • Filament wound parts • Materials and components engineered to perform specific functions • Pre-impregnated materials in filament, tape, wide sheet or roll

New Electronic Products

Flight Modules

Twenty sub-miniature standard modules, designed for ultra-reliable operation in missile and space flight environments, are in production. The modules have a density of 350,000 parts per cu ft. They employ standard components to maximize circuitry stability.—Marshall Labs.

Circle 145 on Inquiry Card for more data

Magnetron

Type XM-4218 is a 4 lb 32 kw ka-band (34.8 to 35.4 kmc) unit designed for missile and airborne applications including surveillance, mapping and fire control. It operates at 33,000 ft without capsule pressurization or potting compound. With a peak power output of 32 kw, it can withstand 10 G vibration.—Electronic Tube Div., Sylvania Electric Products.

Circle 146 on Inquiry Card for more data

Recorder/Reproducers

CM-100 series of video band recorder/reproducers can record and reproduce frequencies to 1.2 meg when the magnetic tape is run at a speed of 120 in. per sec. Capable of recording and reproducing both pulse and analog signals.—Mincom Div., Minnesota Mining and Manufacturing.

Circle 147 on Inquiry Card for more data

Thermocouples

New HT Micro-Miniature Thermocouples are now being offered as the world's smallest and most sensitive temperature sensors. They are now being marketed to meet increasing demand for fast, accurate temperature measurement instrumentation for use in the range from cryogenic environments to +3000° F.

Typical applications include rocket fuel temperature measurement, skin temperature on missiles and high speed air-craft, and jet engine exhaust temperatures.—High Temperature Instruments Corp.

Circle 148 on Inquiry Card for more data

Warning System

Electronic warning device, a navigation instrument failure warning system, provides both audible and visual warning in the event of the failure or malfunction of selected instruments.

The system adds less than ten lb to the weight of the aircraft.—Gables Engineering.

Circle 149 on Inquiry Card for more data

Amplifier

New version of 250 series industrial laboratory power amplifier gives a power output of 50 watts with distortion less than 0.25 per cent at full output (mid band). Frequency response is ±0.5 db from 12 cps to 45 K.C.—Arnold & Co.

Circle 150 on Inquiry Card for more data

Amplifier

New DC signal conditioning amplifier is available for missile telemetering systems. It is designed to amplify the output from gauges, thermocouples, or similar low impedance transducers. The input and output signals and the input power are all mutually DC isolated.—Electro Development Corp.

Circle 151 on Inquiry Card for more data

Avscan

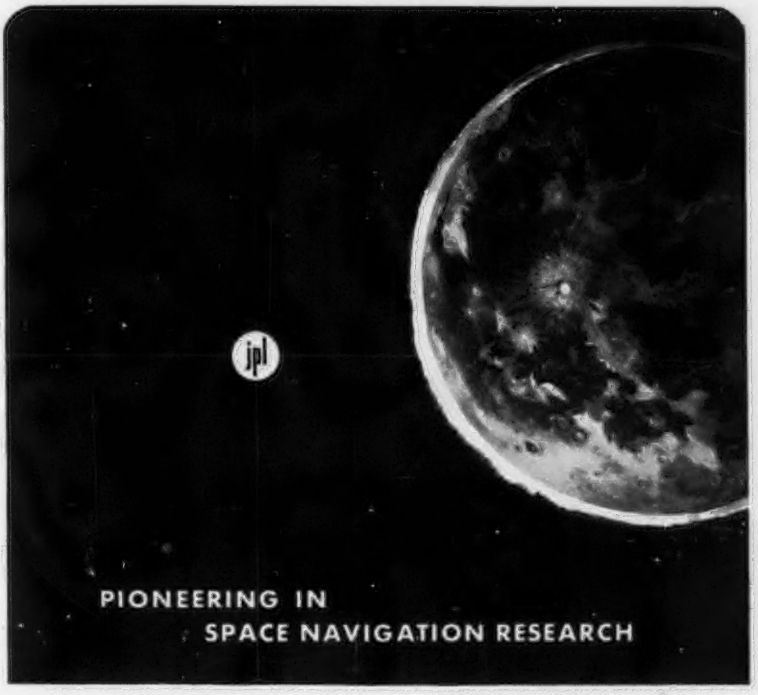
Infrared scanning device, called Avscan, may be used to detect enemy missiles or airplanes. In a small size version, Avscan employs a three in. display tube for recording heat-emitting objects. Larger sizes of the unit, suitable for continuous, 24 hr operations, also can be produced. Unit consists of four major parts—a scanning head, a signal processing unit, a display unit and a cryogenic cooling supply.—Avco Electronics and Ordnance Div.

Circle 152 on Inquiry Card for more data

Switching Transistor

Germanium switching transistor, an epitaxial mesa unit, has a maximum switching time of only 110 millimicro-sec. Conventional germanium mesa switching transistors perform in the range of 275 millimicro-sec. Designated Type 2N781.—Sylvania Electric.

Circle 153 on Inquiry Card for more data



The Jet Propulsion Laboratory in Pasadena, California, has been given the responsibility by the National Aeronautics and Space Administration of managing and executing a number of highly significant explorations in space. They include lunar and planetary missions such as fly-bys, orbiters, and unmanned roving vehicles for the observation of the surface of the moon and the planets. Other missions planned for the future involve trips outside of the ecliptic and beyond the confines of the solar system.

The successful execution of these programs requires extensive research efforts of a basic nature in the areas of celestial navigation and the guidance and control of vehicles operating far out in space. The problem areas being investigated include novel concepts in navigation based on astrophysical phenomena as well as research on inertial, optical, and electro-optical sensors of various types.

Other examples of present research activities in this area are cryogenic studies related to gyro and computer techniques, gas lubrication and flotation of sensing masses, research in solid-state physics, and many others.

The Laboratory has a number of positions open for scientists who are interested in working on challenging problems in these areas and who have the ability to investigate novel concepts and try unconventional methods.

Applicants must have an outstanding academic background with a Ph.D. degree, or equivalent experience and a Masters degree, in physics, astronomy, or electrical engineering. A minimum of five years of industrial or academic experience in the following fields will normally be required: **optical physics, astrophysics, cryogenics, inertial guidance, celestial navigation,** and **computer and logic devices.**

Qualified scientists will be offered the opportunity to work in an unusually stimulating atmosphere and will have available excellent supporting facilities for experimental and analytical studies.

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JET PROPULSION LABORATORY

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New Electronic Products

Amplifier

Miniature amplifier, a traveling wave tube named the STX-182, is expected to produce up to 40 watts of power over an extremely broad

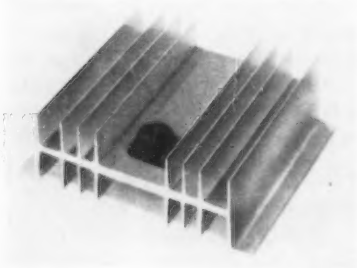
frequency range to magnify simultaneously a great number of signals between earth and a satellite or between satellites. To generate the power, scientists perfected an electron beam focusing structure to assure the exact aiming of highly concentrated electrical energy down the length of the tube.—Sperry Gyroscope Co.

Circle 154 on Inquiry Card for more data

Heat Radiator

Heat radiators are designed for high-powered transistors and diodes where 50, 100, 200 and higher wattage dissipation is required. Radiators also function as a chassis in which transistors or diodes can be mounted on one side and components on the other. Due to very low thermal resistance and high radiation capability of the fins, the radiator approaches in efficiency an infinite heat sink. Width is 4 1/2-in., lengths available in 1/2 in. increments to 12-ft.—The Birtcher Corp.

Circle 155 on Inquiry Card for more data



Synchro Offered Aircraft Instruments

Synchro can be used in fuel flow instruments, hydraulic pressure indicators and torque indicators. It is a size 11 unit with a servo-type mounting. Designed for quantity production in the moderate cost area. Nominal operating specifications include input of 26 volts at 400 cps and .4 watts power consumption. Output is 11.8 volts maximum. Repeater positioning error is not more than 30 minutes.—Courter Products Div., Model Engineering & Manufacturing Corp.

Circle 156 on Inquiry Card for more data

Recording Voltmeter

Recording voltmeter is designed for monitoring voltage fluctuations even when unattended for expended periods of time.

Designated Model 1122B-60, unit operates with a recorder designed to provide chart deflections with amplitudes two to three times greater than standard voltmeters. It responds fully to a 100 millisecond pulse, compared with approximately 1 sec. for a dynamometer type unit, or .5 sec. for a rectifier type.—Brenner-Fiedler Asso.

Circle 157 on Inquiry Card for more data

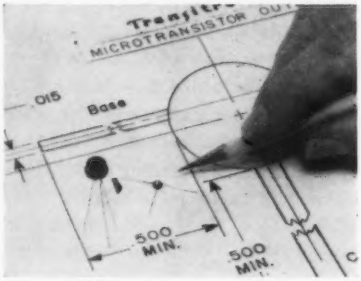
Telemetering Filters

Telemetering filters are miniaturized to meet requirements for missile or airborne telemetering systems. Totally encapsulated, units measure 23/32in. x 23/32in. x 1⅜ in. long. They weigh only 1 oz. Available with center frequencies from 1.7 KC to 70 KC (Stc. I.R.I.G. Freq.) with impedance of 51 K ohms. Attenuation characteristics are less than 3 db at ±7½ per cent and more than 20 db at ±27 per cent of the center frequency.—Filter Div., Control Electronics Co.

Circle 158 on Inquiry Card for more data

Micro-Transistors

First line of micro-transistors in all glass packages has been introduced. Series of 45-volt silicon



mesa devices has operating current range of 50 microamps, to 20 milliamps. They represent the first micro-transistors produced for small signal low level application. —Transitron Electronic Corp.

Circle 159 on Inquiry Card for more data

Potentiometers

New deposited film precision potentiometers provide resolution of better than 0.1 per cent. They are for use where small increments of shaft rotation must produce proportionally small changes in resistance.

Potentiometer resistance element is manufactured in a high vacuum chamber using electron bombardment techniques. This method provides a thin film metallic resistance element of extremely fine granularity capable of being resolved into infinitesimally small changes in resistance.—Mechatrol, Div. of Servomechanisms Inc.

Circle 160 on Inquiry Card for more data

New Parts and Components

Flow Transducers

Flow transducers, designed for missiles using thrust vector control, have ranges of 0 to 0.5 gps through 0 to 200 gpm. To satisfy the needs of telemetry systems, a signal conditioning amplifier can be incorporated in the transducer which will provide a V full scale output.—Standard Controls Inc.

Circle 161 on Inquiry Card for more data

Lightweight Mirrors

Optical mirrors for airborne systems can now be made five to ten times lighter than conventional optical parts. New process utilizing a honeycomb crosssection of the mirror keeps rigidity of reflecting surface. These mirrors have held surfaces accurate to a tenth of a wavelength of light across a 12 in. diam. for more than 2 years. Can be furnished as flats, spheres in diam. up to 48 in. Made of glass or quartz, these units will withstand temperature variations of —80 deg. to +165 deg. F.—Precision Lapping Co.

Circle 162 on Inquiry Card for more data

Accelerometer Unit

Integrally lighted (red and white) MA-2 accelerometer is designed to sense vertical acceleration from —2 g to +8 g with an accuracy of .2 g. Acceleration is indicated by an indicating pointer.—Burton Manufacturing Co.

Circle 163 on Inquiry Card for more data

Missile Switch

Four-pole, double-throw switch combines special contact design with a plunger and spring-operating mechanism for position stability. In one current application, a lanyard attached to the ground holds the switch in one position. When the missile lifts off the pad, the lanyard pulls out, actuating the switch.—Kinetics Corp.

Circle 164 on Inquiry Card for more data

Precision Bearings

Precision bearings with 14 vital dimensions held within tolerances of .000020 in. are now being manufactured in production lots. This "giant step" in precision-bearing technology is the result of a program initiated by MIT instrumentation Laboratory under Air Force sponsorship in 1956. Bearings are designed for ICBM inertial systems. —The Barden Corp.

Circle 165 on Inquiry Card for more data

Automatic Battery

Silver-zinc primary battery activates itself within a maximum of 15 sec. The 28 ESB Model 70 battery will discharge for 12 min with an electrical load of five amps. The voltage is regulated to limit fluctuation to plus-or-minus 5.4 per cent of the 5-amp load.—Missile Battery Div. The Electric Storage Battery Co.

Circle 166 on Inquiry Card for more data

Relay

Precision relay, called the Dyna-Mite, measures only .2 by .4 by .6 in. and has a volume of .048 cu in. It is sensitive (10 milliwatts), yet has only 1/16th the volume of a standard micro-miniature relay. Weight: .1 oz. It has been vibrated to 45 g's without failure and has withstood 100 g's shock.—Control Dynamics Corp.

Circle 167 on Inquiry Card for more data

continued on next page

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RELIABILITY

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2200
2300

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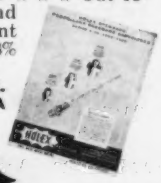
STANDARD PROPELLANT PRESSURE CARTRIDGES

Available from stock in 41 incremental energy output ratings from 17 to 695 foot-pounds, for actuating valves, cable-cutters, pin-pullers and other explosively-operated mechanisms in missiles and space-craft ★ ★ ★ Cut research and development time. 99.98% reliability!



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Design, Development Test and Manufacture of Precision Explosive Components.

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Circle 29 on Inquiry Card

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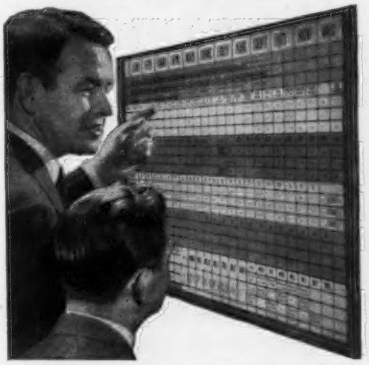

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GRAPHIC SYSTEMS

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Circle 30 on Inquiry Card

New Parts and Components

Vacuum Accessories

Accessories for use with vacuum evaporators consist of a series of collars which fit in the vacuum system between the bell jar and the base plate of most commercial evaporators. Ports with identical flange fittings are around the collar. A flange and feed-through may be connected to each port. — Vacuum Technology Inc.

Circle 171 on Inquiry Card for more data

Transceiver System

Lightweight high frequency transceiver system is designed for airborne applications requiring high power and long range communications. This "HC-101" transceiver consists of a receiver-transmitter group and a single sideband converter. It weighs about 150 lb.—Hughes Aircraft.

Circle 172 on Inquiry Card for more data

Miniature Gyro

Inertial guidance gyro has demonstrated performance at least three times better than other vest pocket size gyroscopes. This "SYG-1000" floated integrating miniature gyro weighs less than one lb. Length is under three in. Drift sensitivity: less than .005 deg per hr/g^2 under vibration tests involving gravity forces multiplied up to 20 times.—Sperry Gyroscope Co.

Circle 173 on Inquiry Card for more data

Missile Motor

Limited-duty-cycle, DC electric motor is designed for missile environments. It weighs 6.7 lb. and produces 3.25 at 13,700 rpm using 30

V dc power. Its high power-to-weight ratio and over-all efficiency of 75 per cent are said to be exceptional for missile auxiliary power drive equipment.—Task Corp.

Circle 174 on Inquiry Card for more data

Heading Indicator

Compact indicator give data on 2 relative bearings, distance and magnetic heading, all on a single indicator face 3.25 in. square. It transmits any selected course to the autopilot by a hand knob. Built-in safety features make the knob inoperative if autopilot malfunctions, and also indicate power failures.—John Oster Manufacturing Co.

Circle 175 on Inquiry Card for more data

Accelerometer

The Model 706 is a general purpose unit that features simple bolt down mounting through a center clearance hole. This makes possible rotation of the output connector to any convenient direction in the plane perpendicular to its sensitive axis. Use: measuring shock and vibration in missile and airborne vehicles and in standard laboratory acceleraton measuring systems.—Columbia Research Labs.

Circle 176 on Inquiry Card for more data

Reflector

Inflatable bowl-shaped reflector collects solar energy to operate electrical power generating systems providing three kilowatts and up. It is under intensive study for a number of astronautical applications — Goodyear Aircraft

Circle 177 on Inquiry Card for more data

Aircraft Seat

Fatigue is reduced to a minimum in a new design luxury-type aircraft seat. Named the Euphorian (U-For-IAN), the seat was designed by a team of medical and aeronautical groups. It cradles the body in a curve of maximum support, thus eliminating fatigue points.—Century Universal Corp.

Circle 178 on Inquiry Card for more data

Variable Area Nozzle

Advanced concept in fuel injection has enabled combining the low flow range characteristics of the simplex nozzle with the linear high flow range characteristics of the variable area poppet injector. Photo

illustrates the dual spray cones of highly-atomized fuel when transition from simplex to variable area linear flow occurs.—The Engineered Products Co.

Circle 179 on Inquiry Card for more data

Umbilical Connector

Missile umbilical connector absorbed 20,000,000 ft. lb. of energy in vibration tests. Accelerations of up to 60 g were achieved. Design principles have been under development for over two years.—Cannon Electric Co.

Circle 190 on Inquiry Card for more data

Flexible Tubing

A new type of flexible tubing, weighing less than half the weight of other fabric-covered ducts, has been developed for air conditioning and heating ductwork in aircraft.

Sikorsky specified the lightweight tubing for its amphibious S-61L. It saved 10 lb in the air conditioning system—Flexible Tubing Corp.

Circle 168 on Inquiry Card for more data

Beryllium Bolts

Strongest metal fasteners for their weight ever produced are now being made of beryllium metal, one-fourth the weight of steel. The new SPS beryllium shear bolts are called twice as strong as the best comparable steel superbolts.

A highlight of the development was isolation of the real source of much of beryllium's structural troubles to date—its notch sensitivity.

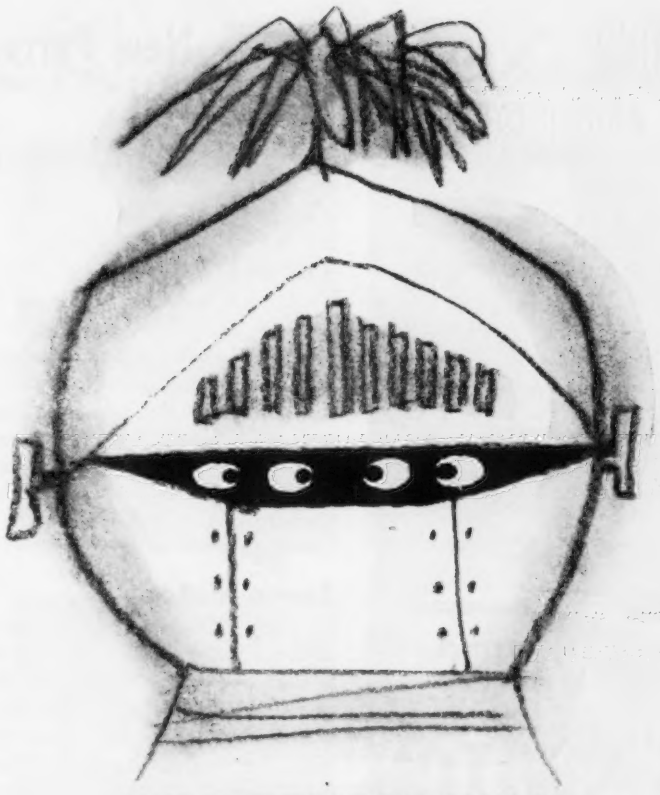
The bolts will find initial application in satellites and in missile guidance and structural systems.—Standard Pressed Steel Co.

Circle 169 on Inquiry Card for more data

Navigation Display

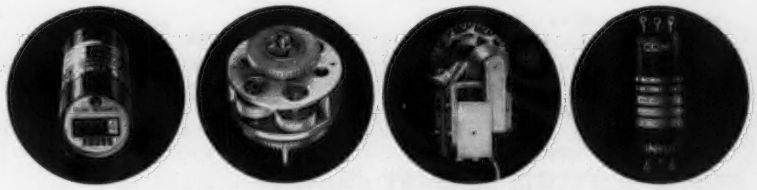
All-weather pictorial navigation display unit for commercial and business aircraft utilizes a moving reticle of "bug," representing an aircraft. "Bug" moves freely under a transparent display map to indicate the aircraft's position above the ground. Unit is six in. square and either three-and-a-half or two in. deep. Weight is five or four lb. —ACF Electronics Div.

Circle 170 on Inquiry Card for more data



TOGETHERNESS:

This little piece could have been titled "Look again, Lancelot" or "Jousting Cheek to Cheek." Then we'd whip up an amusing little allegory and lead into a clever punch line... but there isn't room, so we'll come right to the point. Elgin Micronics is specially organized and qualified to work with your staff on any project involving sub-miniature precision component assemblies—mechanical, electro-mechanical or electronic—at any stage from concept and basic research through quantity production. Let's put our heads together.



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Circle 31 on Inquiry Card

FOR "BIRDS" OR BOXCARS

APPROX. ACTUAL SIZE

New PACIFIC "G" SENSING INERTIA SWITCH

...provides high performance

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Pacific's new inertia switch is readily adaptable to meet a variety of "G" sensing uses from missiles to freight cars. It permits a wide variation in performance and range with only a minimum of engineering and development to meet specific requirements. A unique switching action provides positive "make or break" action of the electrical contacts at the "G" setting regardless of environmental conditions.

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Circle 32 on Inquiry Card

New Parts and Components

. . . continued

Poppet Valve

Poppet valve is designed to operate at 950°F. A radiation resistant solenoid is used in special applications where radiation is likely to occur. Maximum operating pressure is 265 psig. Internal leakage is .04 lb/min at 265 psig and 530°F. Unit weighs 1.85 lb. — Barber-Colman

Circle 180 on Inquiry Card for more data

Servo Motor

The J126-06 miniature servo motor is only one-half inch in diameter and 0.968 inch long. Designed for use in servo systems where instant response is needed. Available in a variety of shaft configurations. Control phase designed for operation by transistorized servo amplifiers. — Kearfott

Circle 181 on Inquiry Card for more data

Sofar Bomb System

Sofar sound generator (for underwater detonation) weighs 30 per cent less than similar devices. It has a completely-out-of-line, 90° rotational fuze rotor for failure-proof self-arming and safeing. Absence of shear sliding mechanisms makes the fuze mechanism impervious to side "g" forces. It will withstand temperatures of 350°F continuous, or 500°F for 20 minutes.—The Mimx Corp.

Circle 182 on Inquiry Card for more data

Navigation System

Airborne navigation system operates from the primary aircraft power supply. No separate a/c power unit or rotating machinery is required.

Heart of the system is its highly sensitive Model 501A receiver, which includes the tuning meter. The large indicator dial covers a full 360°. System is for single-engine aircraft.—Aircraft Radio Corp.

Circle 183 on Inquiry Card for more data

X-15 Valve

Main dual propellant valve is the heart of Thiokol's XLR99 rocket engine for the X-15. This valve handles some 12,000 lb of liquid oxygen and ammonia per minute at full throttle and, with four other Flo-Ball valves in the first and second igniter stages, allows pilot to throttle engine from 25,000 to 50,000 lb thrust.—Hydromatics, Inc.

Circle 184 on Inquiry Card for more data

Lightweight Valve

Solenoid-operated shut-off valve is now in pilot production. The ⅛ in. model of the new valve weighs less than two oz. Port sizes from 1/16 in. to ½ in. are practical: Unitized body of aluminum and stainless steel integrates line connection, hamber seats and plunger sleeve.—Polymet Co.

Circle 185 on Inquiry Card for more data

Aircraft Communicator

Push-button communications device enables a jet pilot to "talk" to his base with speed and accuracy. Called "Digikey," device permits a pilot or crewman to "talk" through

heavy electrical interference at a rate of 150 words per minute by punching keys on a small semi-automatic keyboard. Digikey converts a message into digital form. It transmits through a communications system to a ground station. Here the digits are reconverted into words and displayed in printed form on a receiver unit.—Hughes Aircraft

Circle 186 on Inquiry Card for more data

Socket Screw

New austenitic stainless steel fasteners have minimum rated tensile strength of 125,000 psi. Higher design strengths result from a 304 austenitic material with high corrosion resistance. Operating range of the KS 812 series screws is minus 300 degrees to plus 800 degrees F. —Standard Pressed Steel Co.

Circle 187 on Inquiry Card for more data

High Temperature Wrenching Bolts

Line of internal wrenching bolts is for high temperature applications to 1800°F. Bolts are stocked for prompt shipment in most popular thread sizes and lengths made in high temperature material AMS 5735. Tensile strengths: 130,000 p.s.i. minimum. Fasteners can be supplied promptly in such materials as 19-9DL, Inconel X, M-252, Titanium, other heat resistant space age alloys. — Mercury Air Parts Co.

Circle 188 on Inquiry Card for more data

Filters Missile Hydraulic Fluids

New filter has been developed for filtering sub-micron particles from liquids. Filter unit is based on the use of a porous plastic sheet with uniform sub-micron holes in it. Sponge-like cavity arrangement acts as a sieve to trap all particles of 0.1 micron and above in the filter.— Gelman Instrument Co.

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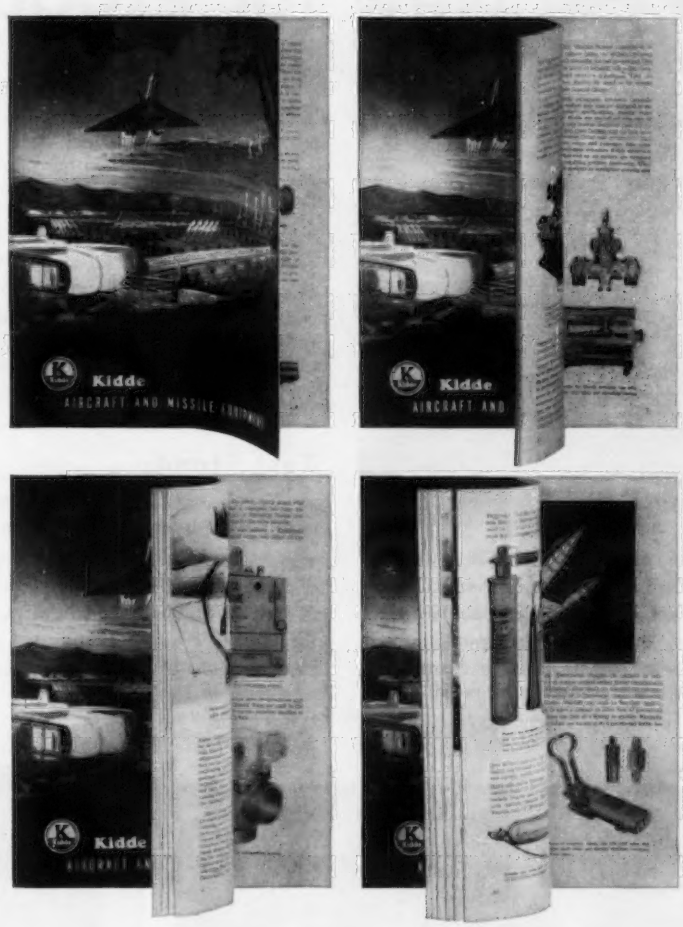

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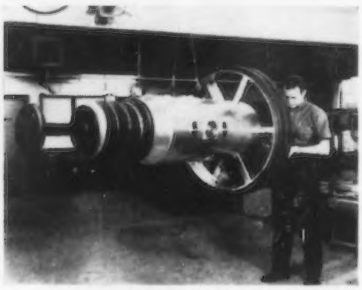
New for Production

Handles Engines

Pneumatic handling device was developed for inserting and removing liquid fuel engines in the first



stage of Saturn. Handling method incorporates a concept of affording a firm but gentle contact with the most even possible application of pressure.—The Presray Corp.

Circle 192 on Inquiry Card for more data

Electronic Filter

Electronic oil filter is designed for decontaminating hydraulic test stands, aircraft hydraulic systems and missile and rocket systems. New product has proven its effectiveness in extensive field test and in applications by a major missile manufacturer.—Permanent Filter Corp.

Circle 193 on Inquiry Card for more data

Test Stand

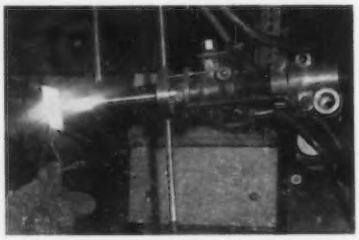
Servo valve test stand automatically plots hydraulic flow rates of as low as 100 drops per min.

Model 2784 records cord in X-Y form combinations of flow, piston force, pressure, and displacement.—Auto-Control Laboratories.

Circle 194 on Inquiry Card for more data

Plasma Torch

Plasma torch can be used for applying high melting point materials as well as reactive materials.



High melting point materials such as zirconia, aluminia and titania as well as refractory and reactive materials like tungsten, tantalum and silicon have been applied with prototypes of the torch.—British Oxygen Research & Development Ltd.

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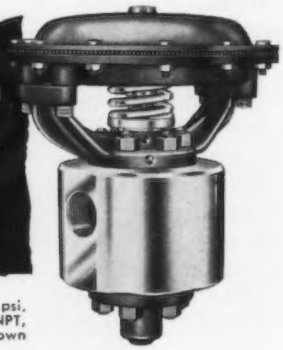
High Pressure Fluid Control a Problem?



Sinclair-Collins 6000 psi, 1 inch NPT, 2-way type shown

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For more information, write for free Bulletin S-C 59. Address Sinclair-Collins Valve Company, Akron 9, Ohio, Dept. AIM-461.

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Circle 35 on Inquiry Card

Heat To 2300°F

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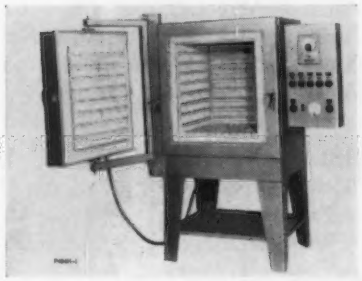

of temperature—and infinite heat-rate control ranging from 300°F to 2300°F—can be maintained by means of input controllers. These can be set from 7 per cent to 100 per cent of input. Gradients are indicated by a pyrometer and two thermocouples located zonewise and a thermocouple selector switch. —L & L Manufacturing Co.

Circle 196 on Inquiry Card for more data

Microminiature Tools

Line of "Microtools" comprises 67 tools, all interchangeable in handles provided. Line embodies active elements from 0.001 to 0.01 in.; each tool is designed for specific microelectronic job.—Circon Component Corp.

Circle 197 on Inquiry Card for more data

Machines Beryllium

Forming tool horizontal and vertical turret lathes provides faster machining of complex, all-beryllium parts.

Each "pineapple" tool consists of a high-carbon tool-steel shank 2⅞ in. in diam. integral with a body of the same material, the work end of which holds six carbide-tipped cutters set at various rake angles, depending on the cutting requirements of the individual tool.—The Beryllium Corp.

Circle 198 on Inquiry Card for more data

Ground Survival

Survival suit was developed to protect rocket fuel handlers from

potentially fatal splash, spray or fumes of high energy rocket propellants. Units include a back carried air-supply and air-conditioning system.—The Firewel Co.

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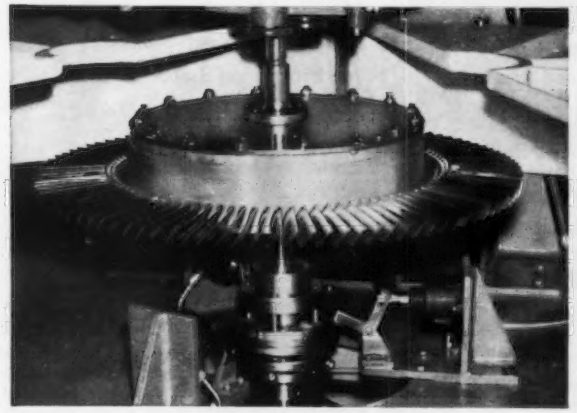

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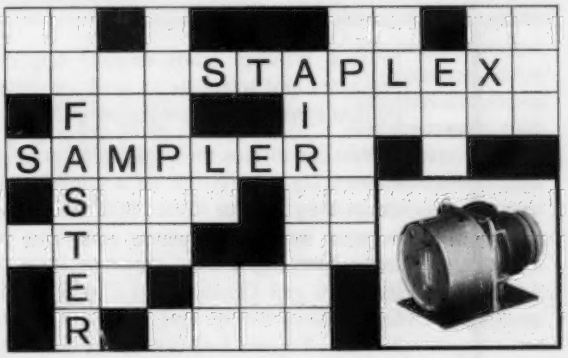

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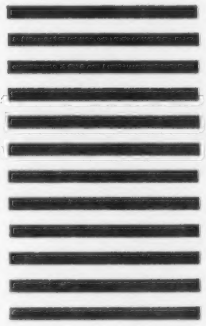

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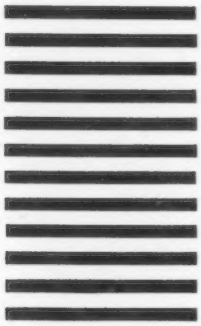

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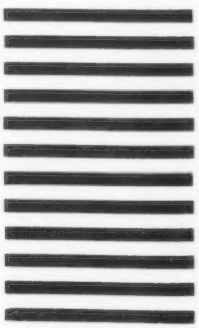

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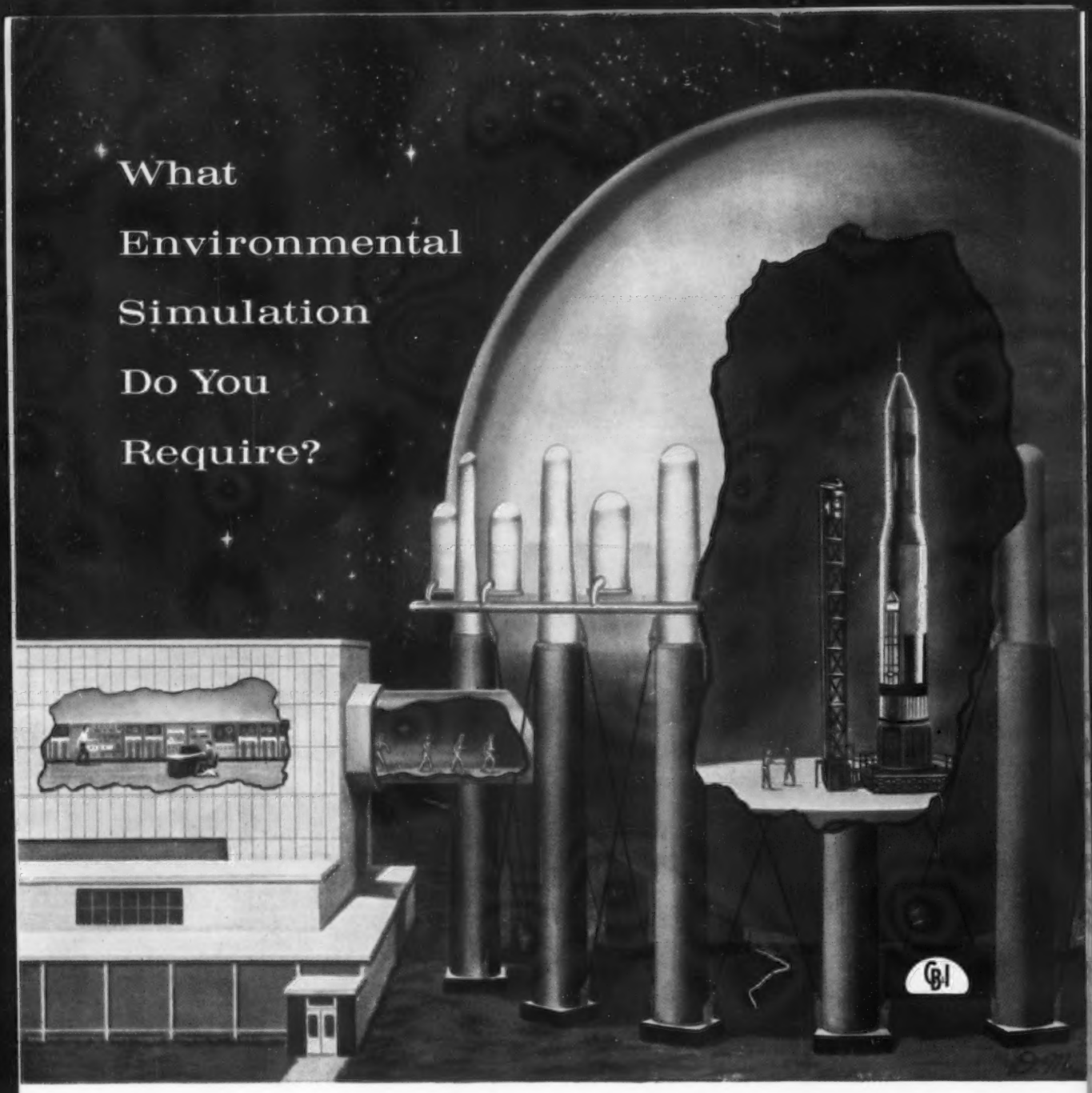

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